

**LEVEL I PM₁₀ ASSESSMENT PACKAGE
USERS' GUIDE**

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ABSTRACT

The Level I PM₁₀ Assessment Package consists of air quality models and interfaces to data bases available to the California Air Resources Board. All software and data bases are manipulated on IBM/PC compatible microcomputers in the DOS operating environment.

The modeling software consists of: 1) a BMDP computer program for the Principal Components Analysis receptor model; 2) a U.S. EPA program for the Chemical Mass Balance receptor model; and 3) a U.S. EPA program for the Industrial Source Complex Short Term dispersion model, modified for error propagation. These models are used sequentially to identify the major source types contributing to PM₁₀ levels in California, to estimate those source-type contributions, and to apportion contributions to source sub-types.

Data bases which are accessed by these models include: 1) the ARB dichotomous sampler network; 2) the Kern County gridded emissions inventory; 3) EPA's source composition library; and 4) National Weather Service surface and upper air station data. Software has been created to select data from these data bases and convert them to appropriate model input formats.

The Level I PM₁₀ Assessment Package is applied to data from the Bakersfield-Chester PM₁₀ sampling site, using June 17, 1983, as an example. The results of this application indicated that geological material was the major contributor to the high PM₁₀ concentration on the example day, and that the source sub-type with the largest contribution was resuspended paved-road dust. The example is illustrative rather than conclusive, however, and the uncertainties associated with the Level I apportionment are great. The Level I PM₁₀ Assessment Package is intended primarily to aid and focus the design of measurement and modeling studies to support Level II PM₁₀ assessment.

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1.0 INTRODUCTION

The Desert Research Institute has prepared a PM₁₀ Level I Assessment Package under the sponsorship of the Air Resources Board of California. This user's guide is a companion to "Model and Data Base Description for California's Level I PM₁₀ Assessment Package" (Watson et al., 1987). This users' manual documents the hardware and software components of the package. An example illustration is included to provide the user with practice and familiarity with package structure and with implementation of package models and programs. More detailed discussions of package components, including their theoretical bases and data requirements, can be found in Watson et al. (1987).

Section 2.0 of the users' guide describes the hardware and software requirements for the package, including brief descriptions of package models, and sources from which hardware and software may be obtained. System setup and configuration are also described in Section 2.0.

Section 3.0 defines all of the programs contained in the package and shows their interrelationship with flow diagrams. Section 3.0 also contains discussions of data handling programs and program modifications that are unique to this package.

Section 4.0 is a step-by-step illustration of the application of package models to data from the Bakersfield-Chester sampling site. The example of the Section 4.0 is illustrative and is not intended to give a definitive analysis. Section 5.0 contains a review of areas of potential improvement that are evident from the example.

2.0 HARDWARE AND SOFTWARE

2.1 Hardware

2.1.1 Personal Computer

Programs included in this package will run on an IBM PC/XT or IBM-compatible personal computer. Some of the programs are large, particularly the BMDP programs, and require a full 640 Kb of memory and a hard disk. The PC must also be equipped with a 8087 floating point coprocessor chip for BMDP software. Without the 8087 coprocessor program execution times for the CMB and ISC models, and for the emissions inventory search program, may be unacceptably long. An IBM PC/XT with a 10 M byte Winchester disk, an AST memory expansion board, and an 8087 coprocessor was provided with this package.

2.1.2 Modem

A modem with communications software may be useful for transferring data files from the ARB computer system to directories in the assessment package. The modem provided with this package is an internal Hayes Smartmodem 1200B, available from Jade Computer Products, 4901 West Rosecrans Avenue, Hawthorne, CA 90250, (213) 973-7707. There are numerous suitable alternatives, including internal and external modems.

2.1.3 Line Printer

A line printer is recommended to provide hard copy of program results. Also, some of the programs produce output in 132 column format that is not easily viewed on a terminal screen, so the printer should have this capability. The printer provided with this package is an Okidata Model 193 line printer. Other models, such as the Epson Model FX286e, are also suitable and can be found at many computer products retail outlets.

2.2 Software

2.2.1 BMDP Statistical Software

The Source Type Identification (Phase I) portion of this package applies statistical programs from BMDP statistical Software. These programs are available from BMDP Statistical Software, Inc., 1964 Westwood Blvd, Suite 202, Los Angeles, CA 90025, (213) 475-5700.

The Level I PM₁₀ Assessment Package uses program 4M (Factor Analysis) from the BMDP group of programs to perform principal component analysis (PCA). This program provides four methods of initial factor extraction from a correlation or covariance matrix and several methods of rotation. The BMDP software accepts as input data: 1) ambient monitoring data; 2) a correlation or covariance matrix; 3) factor loadings; or 4) factor score

coefficients. Output includes: 1) rotated and unrotated factor loadings and their plots; 2) a display of sorted rotated factor loadings; 3) factor score coefficients, scores for each case, and factor score plots; 4) Mahalanobis distances from each case to the centroid of all cases for original data, factor scores and their differences; 5) a correlation matrix; 6) squared multiple correlations of each variable with all others; 7) eigenvalues; 8) optional display of the correlation matrix in sorted and shaded form; and 9) optional listings of data or standard scores, covariance matrix, inverse of correlation or covariance matrix, partial correlations, residual correlations, and double precision computations.

Most of these displays are unnecessary for a Level I assessment and have been suppressed in the standard program provided with this package. Program 4M, for the present purpose, uses PCA to identify factors and correlates them to a set of chemical analyses from ambient particulate concentrations. Chemical species with which these factors are correlated are compared to source emission profiles to identify contributing source types. A large set of samples, typically 80 or more, is necessary to provide reliable source type identification. The source types identified by PCA are not necessarily the only contributors to PM₁₀. PCA is intended to supplement, not to replace, a careful examination of an emissions inventory. PCA identifies uninventoried contributors and confirms the contributions of major emitters in the inventory.

BMDP programs are typically sold in packages of four. If this program is purchased as part of a group of programs, it is recommended that program 1R (Multiple Linear Regression) also be obtained. Although not a part of the Level I PM₁₀ Assessment Package, and not discussed in detail in this document, this program is useful for performing additional regression analyses beyond those performed with 4M and which are appropriate for a Level II PM₁₀ assessment. Program 1R provides means for estimating a least squares regression equation between a dependent (predicted) variable and one or more independent (predictor) variables. The computations are performed on all the data and, if requested, on subsets or groups of cases. The equality of regression lines across groups is tested. The multiple correlation coefficient, standard error of an estimated value, standardized and unstandardized regression coefficients, significance of coefficient and p values are printed. Data, residuals, and predicted values can be plotted in several ways and saved on a BMDP File.

Execution of BMDP programs requires a Master Diskette. This Master is provided, along with statistical programs, on a floppy disk when ordered from BMDP. The Master Diskette contains files for accessing and executing BMDP programs and also functions as a "key" for running the programs. A different Master Diskette must be used according to the Disk Operating System (DOS) Version used with the PC. DOS is discussed in a subsequent section. The version of DOS implemented on a user's computer should be communicated to BMDP when software is purchased.

More detailed discussions of BMDP statistical software program principles, applications, requirements, and sources of additional information may be found in "BMDP Statistical Software, 1985 Revised

Edition" and in "BMDP: Users Guide to BMDP on the IBM PC." These are available from BMDP Statistical Software, Inc., at the address given above.

2.2.2 Chemical Mass Balance Model

The Source Type Apportionment (Phase II) portion of the Level I PM₁₀ Assessment Package uses the Chemical Mass Balance (CMB) Model Version 6 (Axetell et al., 1987; Pace and Watson, 1987). This model is available on floppy disks, with sample input and output data sets, from EPA's Office of Air Quality Planning and Standards. The CMB model uses the chemical composition of a single ambient particulate sample to estimate the relative contributions of different source categories to the particulate mass concentration. The chemical composition of each source category's emissions (termed the source profile) is supplied with the ambient chemical concentrations as model input data. Source profile information is available for Level I PM₁₀ Assessment in EPA's Receptor Model Source Composition Library (Core et al., 1984), portions of which are on disks included with the assessment package. (Level II PM₁₀ assessment requires source profile measurements in the areas under study.)

The CMB returns source contribution estimates for a specific sample, rather than for a set of many particulate samples as is done with PCA. It thus provides a means of for quantitative apportionment of ambient particulate concentrations among different source types. Considerations other than PCA results may be used in selecting sources to include in the CMB. Such considerations could include meteorological conditions (upwind and downwind emitters), time of year (seasonal source types), or time of the week (weekday as opposed to weekend source types).

Additional details on model use, with a review of the CMB's theoretical basis and references to literature sources, can be found in "Revised CMB Users Manual" (Axetell et al., 1987), available from U.S. EPA, Monitoring and Data Analysis Division, Research Triangle Park, NC 27711. The application and validation of the CMB model are detailed by Pace and Watson (1987).

2.2.3 ISCST Dispersion Model

The Source Sub-Type Apportionment (Phase III) portion of the Level I PM₁₀ Assessment Package uses the ISCST (Industrial Source Complex - Short Term) dispersion model. This is a source-oriented model that uses Gaussian-plume algorithms. With this model, specific sources or source sub-groups are taken from the ARB gridded emissions inventory, combined with hourly meteorological data, and used to provide estimates of their relative contributions to ambient PM₁₀ concentrations on a given day.

ISCST is widely-used for estimating ambient concentrations from new or existing sources as part of the regulatory review process and is designed for use in flat or gentle terrain. In the present application, it is limited by availability of required source parameters, which include

valid and current emission factors for point and area sources. It is also limited by the absence of source elevation data and, in some cases, of representative meteorological data. The primary purpose of ISCST modeling in PM₁₀ assessment, however, is to estimate the relative importance of source sub-types rather than to estimate maximum contributions of specific sources to ambient concentrations. ISCST provides a tool for apportioning specific sub-types within the general source types identified and apportioned by the PCA and CMB models.

ISCST is available from NTIS as part of the UNAMAP (Users Network for Applied Modeling of Air Pollution) package of dispersion models. Three forms of the ISCST model are provided with this package:

1. The standard UNAMAP Version 6 (U.S. EPA, 1986) version of ISCST, modified for use on a personal computer by Pat Hanrahan of the Oregon Department of Environmental Quality. This most recent version of ISCST includes various upgrades, including program changes related to plume rise and stack downwash algorithms. Documentation and model description are included in the ISCST User's Guide, Volumes I and II (Wackter and Foster, 1986), available from NTIS.
2. ISCSTEP, Version 3.0, the Version 6 ISCST model modified for error propagation, developed at the Desert Research Institute. This version accepts input data uncertainty estimates along with data values to provide corresponding uncertainty estimates for calculated concentrations. Error propagation is performed using methods described in Freeman, et al. (1986).
3. ARBISCEP, a modified version of ISCSTEP for use in the Level I PM₁₀ Assessment Package. Modifications were made to permit convenient interfacing with ARB's emissions inventory data base. Program modifications are discussed in Section 3.4.

The ISCST UNAMAP computer code has been submitted to only those modifications (i.e., file addressing, array specifications) which are needed to adapt it to Microsoft PC FORTRAN. This version is, therefore, appropriate for use in regulatory activities, as specified in the EPA's modeling guidelines. ISCSTEP and ARBISCEP have had their computer codes modified to accommodate error propagation. Results from these modified codes were compared to those from ISCST, and the values obtained were identical. Nevertheless, full EPA equivalency requirements have not been met. The ISCST code should be applied to the same input data to verify final results from ISCSTEP and ARBISCEP prior to regulatory decision making.

2.2.4 EPA Source Composition Library

CMB model inputs include chemical compositions of source types and the uncertainties of those compositions. Required information includes typical percent composition of various elements and compounds for fine (<

2.5 μm) and coarse (2.5 - 10 μm) particle size fractions of particulate emissions. Several of these source profiles are included in software provided with the assessment package. Additional source profiles can be found in the "Receptor Model Source Composition Library" (Core et al., 1984). Source profiles can be manually entered, or they can be translated from a diskette version using the conversion program contained in this package. EPA is planning to support computer-compatible versions of the source composition library in the near future.

2.2.5 Data Manipulation Software

Various programs are used in the Level I PM_{10} Assessment Package for reading and converting data to input formats required by package models. Data manipulation routines are unique to this package and are discussed in subsequent sections.

2.2.6 Text Editor

The Zenword screen-oriented editor is supplied with the assessment package for program and data file editing. Any other editor can be used for this purpose. Zenword commands are described in a file entitled ZWHELP and may be examined with the command:

C>ZWHELP

C> is a DOS prompt. Only the letters after the prompt are actually entered. This command executes the batch file ZWHELP.BAT in the Zenword directory and loads the documentation text into the Zenword editor. Cursor keys can be used to step through the documentation. To enter the Zenword editor and edit a file with the name [filename], type:

C>ZW[filename]

2.2.7 Communications Software

A Smartcom II communications software package was included with the Hayes Smartmodem. Alternative communications software includes Softerm PC and DG-Blast, both of which incorporate error-free data transfer protocols compatible with the Data General MV 4000 computer system at ARB. The Smartcom II software does not contain this feature in a form compatible with the DG system. Format specifications for communication links with the DG computer system are 1200 baud, 8 data bits, 1 stop bit, no parity, full duplex.

At the time of this writing, ARB is changing from the DG MV 4000 to a Prime system. Changes will include alternative methods of downloading data. Further guidance concerning communications software and transmission links with the new system is available from ARB's Technical Support Division, Data Processing Branch.

2.2.8 DOS (Disk Operating System)

Programs included in the assessment package are written to run with DOS Version 2.0 or later. The BMDP Master Diskette, necessary for execution of BMDP statistical software programs, may be different depending upon whether the PC uses DOS 2.0/2.1 or DOS 3.0 or later.

2.2.9 FORTRAN Compiler

Certain of the assessment package programs will require modifications in some instances, particularly the programs for reading ARB Emissions Inventory files. Also, the user may wish to modify some of the ISCST routines provided here or as provided by NTIS. Program modifications will require a FORTRAN compiler. The Microsoft FORTRAN Compiler provides a standard FORTRAN Compilation system that is widely used, although others, such as Ryan-McFarland's RM/FORTRAN, are available. Programs in this package were compiled and linked using the Microsoft Version 4.01 Fortran Compiler. The Microsoft compiler can be found in most computer retail outlets or can be obtained from Microsoft, 10700 Northrup Way, Bellevue, WA 98004.

2.3 System Configuration

2.3.1 Required System Commands

Certain system commands are required when the PC system is booted. To execute these commands, the top-level (root) directory should contain a CONFIG.SYS file and an AUTOEXEC.BAT file. The CONFIG.SYS file should contain the following commands:

```
DEVICE=ANSI.SYS
BUFFERS=15
FILES=24
```

The ANSI.SYS file is supplied with the DOS operating system. The foregoing commands enlarge the amount of buffer space available for storing data and permit up to 24 files to be opened simultaneously. These values are those required for execution of BMDP programs. (CMB6 requires that 14 files be opened simultaneously.)

The AUTOEXEC.BAT file should contain the following commands:

```
PATH C:
SET BMDPSPEC = C:
```

These commands are required for execution of BMDP programs.

2.3.2 Directories and Contents

The Level I PM₁₀ Assessment Package is comprised of the following directories, which are in addition to the root directory:

FACTOR	METDAT
CMB	EMDAT
PARTDAT	ZENWORD
SOURCLIB	COMM
ARBISC	FORTRAN
SRCECODE	

Contents of these directories are publicly available and may be freely copied, except for BMDP programs in the FACTOR directory and proprietary software in the COMM and FORTRAN directories. Table 2.3-1 contains brief descriptions of the contents of the directories. With these directories at the same level of a tree structure, it is easy to go from one package directory to any other package directory with the command:

```
C> CD ..\[new directory]
```

It is often convenient to group these directories in a "PM₁₀" master directory contained in the root directory.

2.3.3 BMDP Software Installation

Most of the directory contents described in the previous section can be transferred to and from floppy disks using standard DOS system commands COPY, BACKUP, and RESTORE. BMDP programs must be copied from BMDP-supplied disks using the BMDPF2D.EXE executable program, contained on the BMDP Master Diskette. The following procedure should be followed to load BMDP programs:

1. Use the following CD command to get into the top level (root) directory:

```
C> CD \
```

2. Edit the CONFIG.SYS and AUTOEXEC.BAT files as described in Section 2.3.1. If BUFFERS or FILES commands already exist in the CONFIG.SYS file, make sure that their values are at least as large as 15 and 24, respectively. (See your IBM PC documentation if necessary.)
3. Insert the BMDP Master Diskette in disk drive A.
4. Enter the FACTOR directory and copy the BMDP.BAT, BMDPRUN.BAT, BMDPINIT.CSD and BMDPF2D.EXE files from the Master diskette with the following commands:

Table 2.3-1

Directories and Contents

<u>Directory</u>	<u>Contents</u>
FACTOR	BMDP programs for Principal Components Analysis and Multiple Linear Regression
CMB	CMB6 executable code and input data files
PARTDAT	ARB dichotomous sampler data from 9 California dichotomous sampler sites and routines for conversion of chemical data to CMB format
SOURCLIB	Selected source profiles from EPA's Source Composition Library and a program for conversion of source profile data to CMB format
ARBISC	Modified ISCST model, ARBISCEP.
METDAT	Meteorological data files and programs for converting NWS Surface Observations to ISCST format. A file with Fresno meteorological data for 62 Bakersfield-Chester sample days, in ISCST format, is included
EMDAT	ARB emissions inventory data for sources near the Bakersfield-Chester site, and programs for converting emissions data to ARBISCEP source data format
ZENWORD	ZENWORD screen-oriented text editor
SRCECODE	Fortran source code
COMM	Communications software
FORTTRAN	Fortran compiler

```
C> COPY A:BMDP.BAT
C> COPY A:BMDPRUN.BAT
C> COPY A:BMDPINIT.CSD
C> COPY A:BMDPF2D.EXE
```

Edit the BMDP.BAT and BMDPINIT.CSD files so that the drive letters are correct. Files and programs common to all BMDP programs are now in place.

5. Remove the Master Diskette from disk drive A and reboot by pressing:

```
C> CTRL-ALT-DEL
```

(This is done by holding down the CTRL and ALT keys while hitting the DEL key.) Rebooting this first time is required to put the new CONFIG.SYS and AUTOEXEC.BAT files into effect. They will subsequently be in effect whenever the PC is turned on.

6. Insert the selected program's diskette (if the program uses more than one diskette, select the one labeled 1) and type the following command:

```
C> BMDPF2D
```

BMDPF2D is the BMDP program for copying from floppy to hard disk. Answer each BMDPF2D question asked. If the program is stored on two disks, the computer will prompt with a request to insert the second diskette after finishing with the first.

To execute a BMDP program, first insert the diskette labeled "MASTER" into drive A and type the BMDP PC command:

```
C> BMDP xx jobfile [outfile]
```

Substitute your choice of program, e.g., 4M (Factor Analysis), for xx. If the optional [outfile] is used, program output will be routed to that file. The [jobfile] is that which contains the BMDP instructions and it is not optional. The PC requires 30 to 60 seconds to load the program into memory. If this installation procedure has been done correctly, BMDP programs can be run from any directory or any disk drive.

2.3.4 Backup Disks

Directories and programs provided with this package are on floppy disks and should be copied into each directory using the DOS command COPY. All directories and contents should be maintained on their backup disks to prevent loss due to computer malfunction or human error.

2.3.5 Source Code

Source (FORTRAN) code for many of the executable programs in the assessment package are contained in the SRCECODE directory. Modifications can be made to any of the programs to adjust the software to other data bases. Modified source code should also be backed up as modifications are implemented.

3.0 LEVEL I PM₁₀ ASSESSMENT PACKAGE COMPONENTS

3.1 Phases of Assessment Package

The Level I PM₁₀ Assessment Package consists of three phases:

- o Phase I - Source Type Identification. Principal Components Analysis identifies source categories that are probable contributors to ambient PM₁₀ levels. The main executable program for this phase is the BMDP program 4M - Factor Analysis, contained in the directory FACTOR.
- o Phase II - Source Type Apportionment. The Chemical Mass Balance receptor model apportions ambient PM₁₀ concentrations among major source types. The main executable program for this phase is CMB6, contained in the directory CMB.
- o Phase III - Source Sub-Type Apportionment. The ISCST dispersion model estimates ambient concentrations to a source type from selected sub-types. The main executable program for this phase is ARBISCEP, contained in the directory ARBISC.

3.2 Programs

Table 3.2-1 describes executable programs used in the Level I PM₁₀ Assessment Package. Table entries include each program's directory location, name and function, names and contents of input data files, and names and contents of output data files.

3.3 Flow Diagrams

Flow diagrams for the three phases of the Level I PM₁₀ Assessment Package are given in Figures 3.3-1 to 3.3-3. In these figures, directory locations are indicated by large boxes outlined with dashed lines. Data files, batch files, executable program files, and list files are indicated by different symbols. Dashed flow paths go to intermediate or temporary files used within an executable program. Source library data files in the SOURCLIB directory have names of the form Tnnnnn.PRN. The nnnnn string refers to source category codes in the EPA Source Composition Library. ARB dichotomous sampler data files have names of the form ARBDICOT.iii. The iii string refers to specific sites according to Table 3.3-1. For example, the data file ARBDICOT.BAB is dichotomous sampler data from the Bakersfield-Chester site.

Table 3.2-1

Assessment Package Programs

Program Name and Function	Directory Location	Input Data File Names and Contents	Output Data File Names and Contents
<u>4M</u> Performs Factor Analysis on a set of PM ₁₀ samples	FACTOR	FACTOR.DAT - Contains program control parameters in BMDP format ARB DICOT.iii - Contains data from chemical analysis of dichotomous filter samples for all sample days. iii is the site code, e.g., BAB = Bakersfield-Chester	FACTOR.LST - Contains tables of results from factor analysis of all sample data for the selected site.
<u>CMB6.EXE</u> Chemical Mass Balance Model, performs CMB analysis on an ambient particulate sample for a given day	CMB	INCARB.DAT - List of CMB input data file names. Contained in Directory CMB POCARB.DAT - List of chemical species codes. Contained in Director CMB. SOCARB.DAT - List of source names. Contained in Directory CMB. FSCARB.DAT - Source profiles, fine particle. Created in Director SOURCLIB. CSCARB.DAT - Source profiles, coarse particle. Created in Directory SOURCLIB. DACARB.DAT - Ambient concentration data. Created in Directory PARTDAT.	CMB.LST - Contains tables of results from CMB analysis.
<u>RECEPTOR.EXE</u> Reads ambient PM ₁₀ data in ARB format, along with measurement uncertainties, and converts to input format required by CMB6.	PARTDAT	ARB DICOT.iii - Contains data from chemical analyses of dichotomous filter samples for all sample days. iii is the site code, e.g., BAB = Bakersfield-Chester. RECEPTOR.UNC - Contains measurement uncertainties for chemical species.	DACARB.DAT - Ambient concentrations data for selected sample day, in format required by CMB6.

Table 3.2-1 (continued)

Assessment Package Programs

Program Name and Function	Directory Location	Input Data File Names and Contents	Output Data File Names and Contents
<u>SOURCE.EXE</u> Accesses EPA Source Library files and converts source profiles to formats required by CMB6.	SOURCLIB	SOURCE.DAT - Contains a list of source profile codes to be accessed. Tnnnnn.PRN - Source profile from EPA source library. nnnnn is the EPA numerical code for the selected source category.	FSCARB.DAT - Source profiles, fine particle, in format required by CMB6. CSCARB.DAT - Source profiles, coarse particle, in format required by CMB6.
<u>ARBISCEP.EXE</u> Modified ISCST dispersion model with error propagation. Estimates ambient concentrations from selected source groups for a given day.	ARBISC	ISCINPUT.DAT - Contains standard ARBISCEP program control parameters, source data (created in Directory EMDAT), and hourly meteorological data (created in Directory METDAT). ISC.UNC - Contains measurement uncertainties for variables used as input to ARBISCEP.	ARBISCEP.LST - Results of ARBISCEP model application
<u>EMREAD.EXE</u> Reads emission inventory data in ARB format and converts to format required by ARBISCEP.	EMDAT	NAMEFILE.DAT - Contains names of input emission inventory files and output data files and listings. CARBPS.DAT - Point source data in ARB format. CARBSTAK.DAT - ARB stack file for point sources. CARBRS.DAT - Regional source data in ARB format. CARBMS.DAT - Mobile source data in ARB format.	ISCSOURC.DAT - Source data in format required by ARBISCEP. MESSAGE.LST - Listing of messages from, and summary of, EMREAD run. GROUPn.LST - Column listing of source data found in Emissions Inventory files and reformulated for ARBISCEP. n denotes the source group number. There are n files of this type.

Table 3.2-1 (continued)

Assessment Package Programs

Program Name and Function	Directory Location	Input Data File Names and Contents	Output Data File Names and Contents
<u>MAKEFILE.EXE</u> Creates the program control parameter portion of the ARBISCEP input data file. Program control parameters that are defined by this program are the program title, number of sources, and source group numbers.	EMDAT	EMGRP.DAT - An output file from EMREAD containing the number of sources, number of source groups, and source numbers contained within each group. ISCINPUT.DAT - Data file containing standard ARBISCEP program control parameters in ARBISCEP format, used to create ISCINPUT.TMP portion of ARBISCEP.DAT.	ISCINPUT.TMP - The portion of the ARBISCEP.DAT file containing program control parameters. This is subsequently merged with ISCSOURC.DAT and ISCMET.DAT to create the complete ARBISCEP.DAT file.
<u>METREAD.EXE</u> Reads a file of hourly meteorological data in ISCST format, selects requested day, and creates a new file containing only meteorological data for the selected day.	METDAT	RAMMET2.DAT - Contains hourly meteorological data, in ARBISCEP format, for a set of days.	ISCMET.DAT - Hourly meteorological data, for a given day, in format required by ARBISCEP. ISCMET.DAT is combined with ISCINPUT.TMP and ISCSOURC.DAT to create the input data file ARBISCEP.DAT.
<u>RAMMET2.EXE</u> Reads data from a file containing meteorological data in the NWS format, adds mixing height information, and converts to ISCST (ARBISCEP) format. This is a modified version of the RAMMET program.	METDAT	RAMMET2.INP - Contains control parameters for RAMMET2. NWSMET.DAT - A data file consisting of NWS surface weather observations in original digitized format. RAMMET2.RDM - A table of random numbers used by subroutine RNDM in RAMMET2.	RAMMET2.DAT - Data file consisting of NWS surface meteorological data, and synthesized hourly mixing heights, in the format required by ARBISCEP.

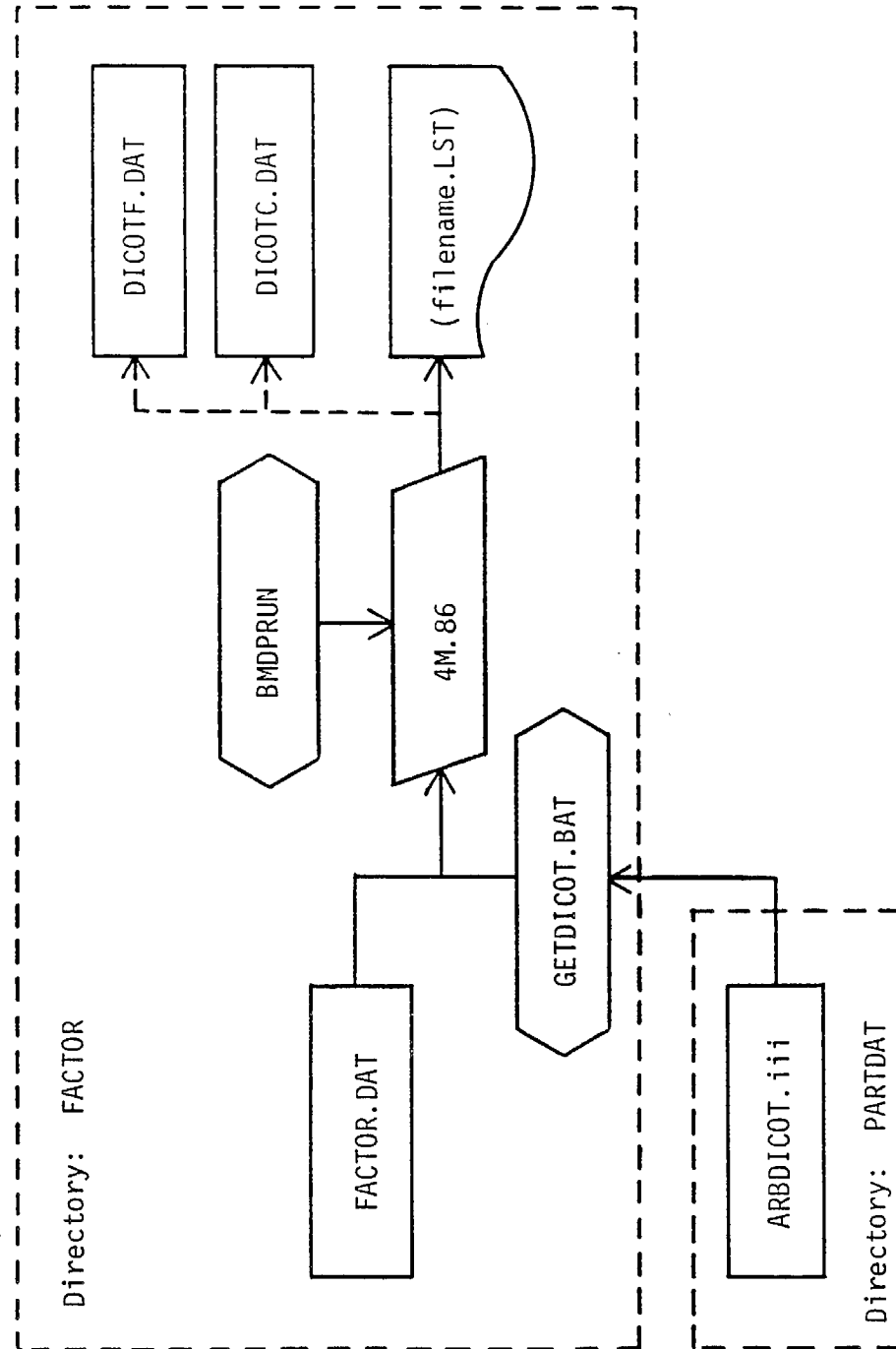


Figure 3.3-1 Flow Diagram for Phase I: Source Type Identification

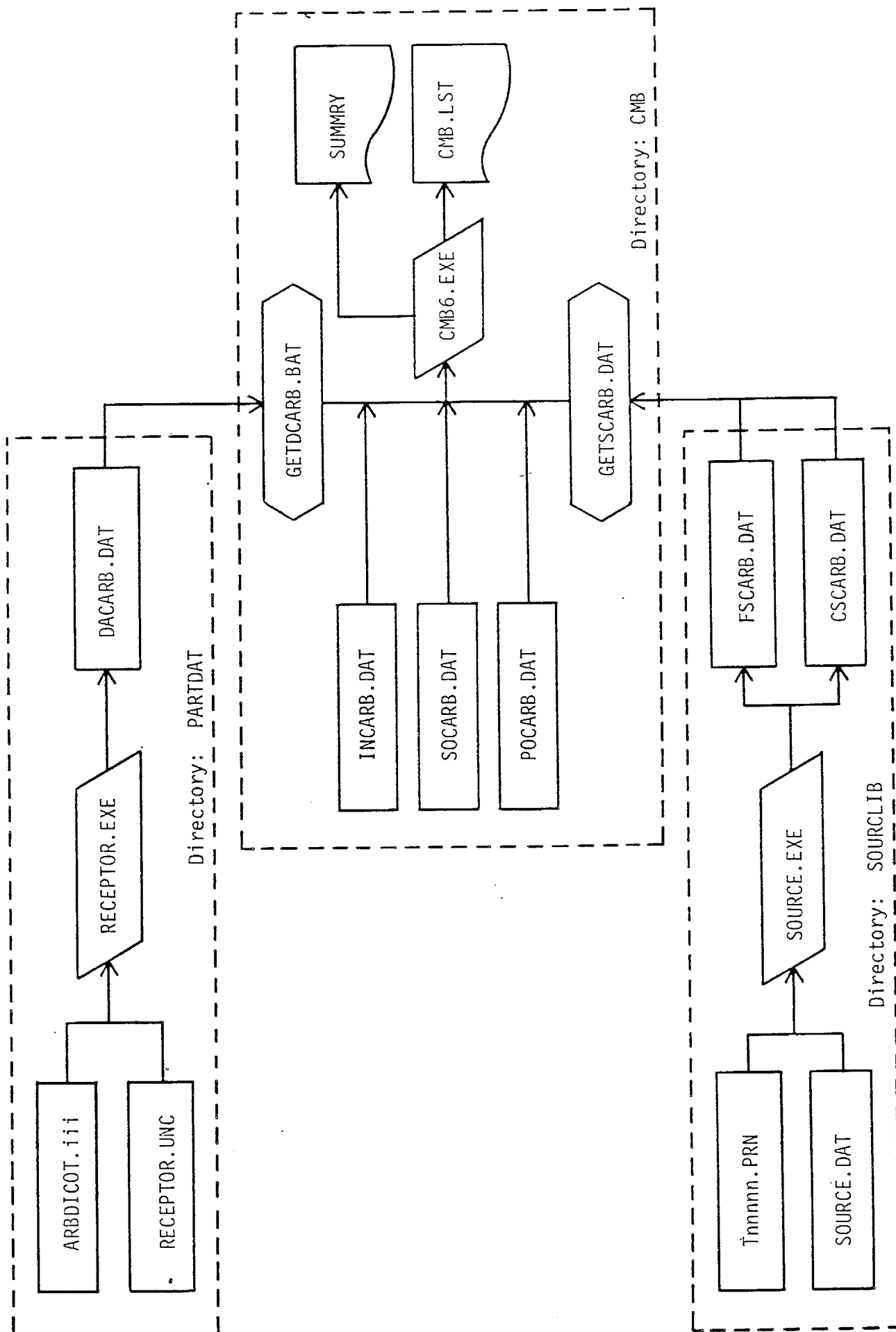


Figure 3.3-2 Flow Diagram for Phase II: Source Type Apportionment

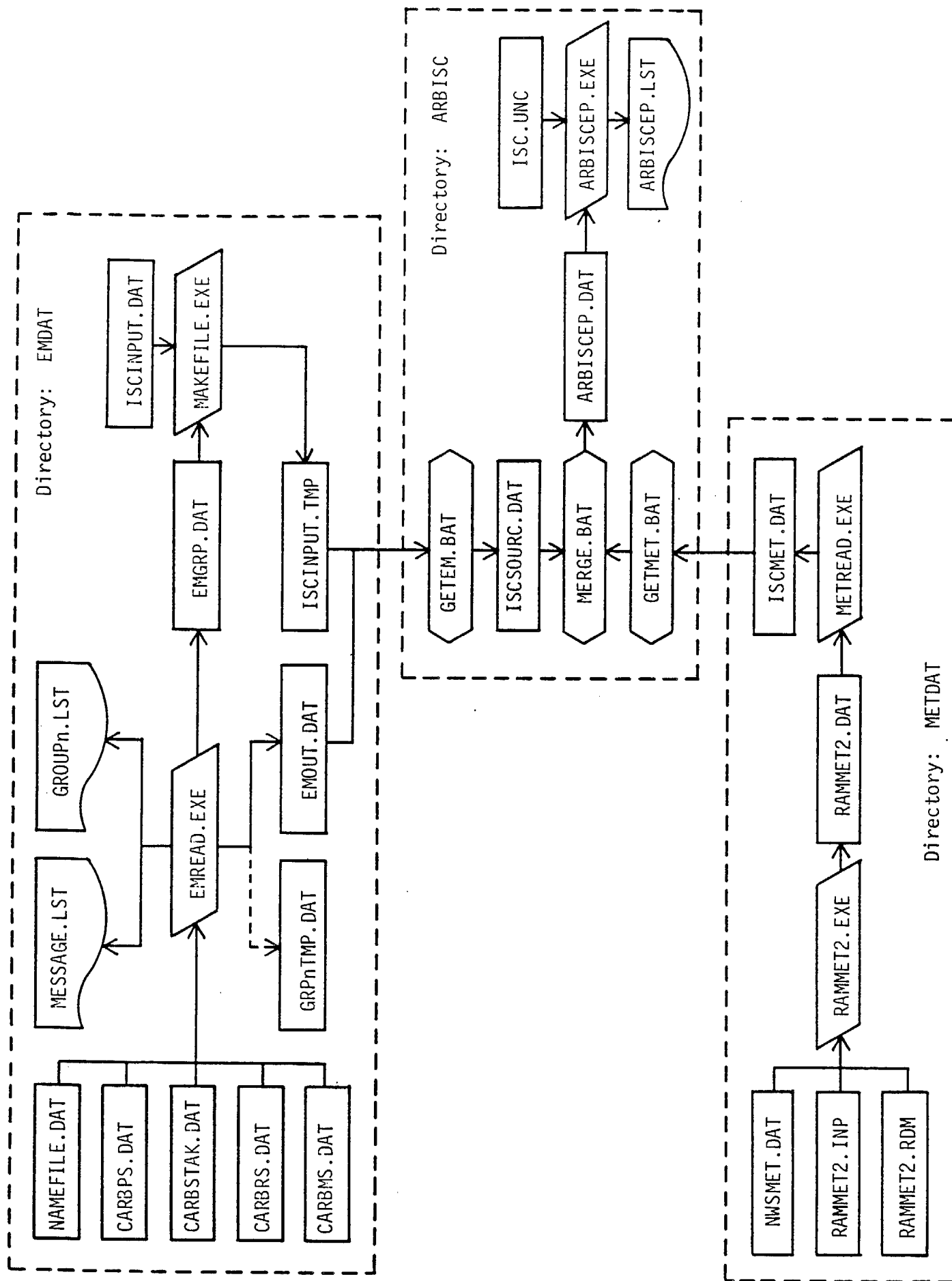


Figure 3.3-3 Flow Diagram for Phase III: Source Sub-Type Apportionment

Table 3.3-1

Dichotomous Sampler Site Codes

<u>Location</u>	<u>Data File String Identifier</u>
Bakersfield	BAB
Fresno	FOF
Riverside	RSL
China Lake	CLX
Glendora	GLL
Rubidoux	RUL
Long Beach	LBL
Yuba City	YCX
Lancaster	LNK

3.4 Additional Program Comments**3.4.1 Modifications to ISCST**

The ISCST model included with the assessment package is non-proprietary Version 6 computer code adapted to the DOS environment by Mr. Pat Hanrahan of the Oregon Department of Environmental Quality. Several modifications were made to the model for use in the assessment package and are discussed in this section. In directory ARBISC, the model has been renamed ARBISCEP and the executable model is in the file ARBISCEP.EXE. Changes in source code are indicated by DRIMMDD in columns 73-80 of modified source (FORTRAN) code statements. Major program changes are as follows:

1. Listing of QTK scalars was made an additional option when listing of all input data is requested with ISW(6). A query for this option is made on the terminal screen when ISW(6) is equal to 1.
2. For sources with diurnal variation, i.e., for which the QFLG parameter > 0, input emission rates from EMREAD are in units of g/day (point sources) or g/m²/day (area sources), rather than in units of g/sec or g/m²/sec. Emission rates for these sources are converted to appropriate ISCST units when multiplied by hourly QTK scalars. This is not an ISCST convention and is unique to the present application.
3. Statements were added to the main calling program and to subroutine DYOUT to allow summaries of source group contributions to be printed at the terminal upon program completion. For this modification to provide valid summaries, source groups must be mutually exclusive, except for the last source group which must consist of all sources.

4. Carriage control (Form Feed) characters were added to all output formats for advancing the carriage of PC peripheral line printers.

3.4.2 Emissions Inventory Read Programs

Program EMREAD in directory EMDAT was written to screen source data in the ARB Kern County emissions inventory for specific source codes and to convert data to the ISCST source input format. This routine was written for the Kern County grid used in the Users' Guide example which follows. EMREAD provides a basis for applications to other grids should they become available, but it will require some modification. The following paragraphs summarize operations performed by EMREAD when converting source data from the Kern County inventory.

1. Source UTM coordinates are converted to ISCST coordinates, in meters, with respect to an origin at the Bakersfield-Chester site, Zone 11 coordinates 316615 m East, 3914545 m North.
2. Coordinate changes account for the 29-degree orientation of the Kern County Grid with respect to compass headings. For area sources (regional and mobile sources), the reference coordinate is the southwest corner of the grid cell, so that area sources, which occupy one grid cell, are effectively rotated 29 degrees clockwise about this point.
3. Area sources close to the Bakersfield-Chester site are subdivided, after the 29-degree rotation, depending on the distance from the Bakersfield-Chester site. Subdivisions are performed when the distance to the center of the area source is less than a minimum distance required by the ISCST model. At most two subdivisions are performed. There will always be at least one subdivided cell that contains the Bakersfield-Chester site, and no ISCST calculations will be performed for emissions in this cell.
4. Diurnal scalar (QTK) records are created for variable sources according to diurnal profile codes used in the ARB emissions inventory.
5. Because of the low emission rates for individual area sources, and to minimize the total number of area sources in the input data file, regional and mobile area sources are combined into single area sources for unique diurnal patterns and source coordinates. Summations are performed over all area sources in a given source group with identical grid size, grid coordinates and diurnal profile codes.
6. Emission rates for diurnal varying sources are in units of g/day or g/day/m², rather than g/sec or g/sec/m². These rates

are converted to appropriate units when multiplied by diurnal QTK scalars in the modified ISCSTEP model, ARBISCEP.

7. Screening options in EMREAD include Point Sources, Regional Sources, and/or Mobile Sources, a minimum daily emission rate (kg/day), selected grid cells to be searched, specific SCC or SIC point source codes, and ranges of CES Codes for area sources (mobile and regional).

3.4.3 Meteorological Data Read Programs

Files in directory METDAT include a modified version of RAMMET, a meteorological data pre-processing program from EPA. The executable program RAMMET2 reads a file consisting of digitized NWS surface data and reformats it to the ISCST data input format. The following modifications were made to the original RAMMET program to create RAMMET2.

1. RAMMET2 reads data in discrete daily blocks of 24 hours each, rather than in one large block of hourly data. Without this modification, RAMMET reads a continuous field and aborts if any hour is out of sequence. With this modification, NWS surface data can be screened and a new file created that consists of only the days requested, rather than all days in sequence. When screening original NWS data files, each day must consist of hours 1-23 of the desired day and hour 00 of the day following.
2. Hourly default mixing heights are synthesized from seasonal morning and afternoon mixing heights found in subroutine MXHGHT. RAMMET2 uses seasonal mean morning mixing heights for Fresno from "Meteorological Parameters For Estimating the Potential for Air Pollution in California" (ARB Staff Report, July, 1974), and seasonal mean afternoon mixing heights interpolated from isopleth charts in Holzworth (1972). Hourly mixing heights are synthesized using Beychock's (1979) method.
3. A FUNCTION subroutine was added to convert calendar dates to Julian dates.

The file NWSMET.DAT consists of original NWS Fresno surface data for the days with PM₁₀ data from Bakersfield-Chester used in the example which follows. RAMMET2.DAT contains reformatted data for these same days, in ISCST format, and was created by applying RAMMET2 to data in the file NWSMET.DAT. The program METREAD selects any desired day from RAMMET2.DAT and copies it to a file named ISCMET.DAT, with no change in format.

Other files in METDAT include RAMMET2.INP and RAMMET2.RDM. The RAMMET2.INP file contains program control information used by RAMMET2, including latitude and longitude for the Fresno NWS station, control codes for random numbers used by RAMMET2 to generate flow vectors, and a code for selection of the sky cover field in the NWS original record format to be

used for stability class calculations. RAMMET2.RDM contains a table of random numbers used by subroutine RNDM in RAMMET2.

To use these programs with NWS surface data from other stations, NWS data should first be screened for the days desired, with each day consisting of hours 1-23 plus hour 00 of the following day, and , when twice-daily mixing heights are not available, appropriate seasonal mixing heights should be inserted into subroutine MXHGHT. Also, the latitude and longitude of the station should be inserted into file RAMMET2.INP.

4.0 EXAMPLE APPLICATION

4.1 Example Selection

This section consists of an illustrative application of PM10 Level I Assessment Package programs to data from Bakersfield-Chester. The particulate data set consists of samples from 93 sample days between March 7, 1983 and January 31, 1985. Data were collected at the Chester site with a dichotomous sampler. Fine and coarse size fractions of PM10 were analyzed for a variety of chemical species, including:

Total Coarse Mass	Cr
Total Fine Mass	Mn
Br	Fe
Pb	K
Cu	Ca
Zn	Si
Ni	Cl
Ti	SO4
V	

For the example analysis, emissions data for sources in the vicinity of the Chester sampling site were taken from ARB's Kern County emissions inventory and transferred to disk files in directory EMDAT. These emissions inventory subsets include all area sources within four 2 km grid cells of the Bakersfield-Chester site. They also include all point sources in the sampling site grid cell and adjacent grid cells and all point sources at farther distances that have particulate emissions exceeding 150 Kg per day or SOX emissions exceeding 250 Kg per day. Stack parameters for point sources are also included in the EMDAT directory.

Meteorological data in directory METDAT include NWS hourly surface observations from Fresno for 83 of the 93 sample days that correspond to the PM10 samples from the Bakersfield-Chester site, and a file containing these same data reformatted for the modified ISCST model, ARBISCEP. The second file, named RAMMET2.DAT, is used in this example application. Programs are also contained in the METDAT directory that will read and format other NWS-format files for use in ARBISCEP, but that are not used in the example. It is recognized that Fresno meteorological data are only marginally representative of conditions at Bakersfield. Fresno is the nearest NWS station for which digitized hourly data are available, and it is suitable for this practice session. For applications of this model to other sites it will be necessary to acquire meteorological data that best represent the site and format them for the ARBISCEP model. Mixing heights used for the Bakersfield-Chester example were synthesized, in subroutine MXHGHT of the meteorological preprocessing program RAMMET2.EXE, from mean morning and afternoon mixing heights as described in Section 3.4.3. These mixing heights are included with meteorological data contained in RAMMET2.DAT.

The remainder of this section contains a step-by-step illustration of the use of assessment package programs to identify and apportion sources of PM10 at Bakersfield-Chester. The purpose for the example is to provide practice and familiarity with package contents, rather than to provide a definitive analysis of PM10 at Bakersfield-Chester. A detailed assessment is most properly performed by a person with familiarity with emissions sources in the vicinity and with local meteorological characteristics.

As the following example proceeds, computer terminal displays are shown as they appear on the screen. DOS commands are preceded by C>. When entering DOS commands, it is not necessary to type these symbols, only subsequent letters and symbols, followed by <enter>. Responses to program prompts should be typed as they appear, followed by <enter>. To stop the screen from scrolling at any time, press <pause>, or CTL-S. Press any key to resume scrolling.

4.2 Phase I - Source Type Identification

This phase uses Principal Components Analysis (PCA) to identify source types that contribute to ambient PM-10 levels. PCA programs are contained in the FACTOR directory. To get into this directory from the root directory, type:

```
C> CD FACTOR
```

Type:

```
C> DIR
```

to view directory contents:

```
Volume in drive C is HARD DISK
Directory of C:\PM10\FACTOR
```

.	<DIR>	1-01-80	12:01a		
..	<DIR>	1-01-80	12:01a		
4M	86	418656	1-01-80	2:48a	Factor analysis program
BMDPRUN	BAT	565	9-06-84	9:28a	BMDP execution batch file
BMDPF2D	EXE	15104	9-06-84	9:29a	Transfers programs from BMDP disks
GETDICOT	BAT	128	1-01-80	3:30a	Retrieves ARB data files from PARTDAT
FACTOR	DAT	1408	1-01-80	3:51a	Control parameters for 4M
7 File(s) 1003520 bytes free					

The executable program 4M.86 must be loaded from BMDP diskettes (see Section 2.3.3). Other files are contained on PM10 assessment package diskettes. Additional explanations of BMDP control files may be found in "BMDPC: User's Guide to BMDP on the IBM PC", available from BMDP Statistical Software, Inc.

PCA is performed on a data set consisting of chemical analysis results from a large number of ambient particulate samples. Data sets for ARB sampling sites are contained in the PARTDAT directory. View PARTDAT directory contents with the commands:

```
C> CD ..\PARTDAT
C> DIR
```

The following is a directory listing for PARTDAT:

Volume in drive C is HARD DISK
Directory of C:\PM10\PARTDAT

	<DIR>	1-01-80	12:09a	Particulate Data For:
..	<DIR>	1-01-80	12:09a	-----
ARBDICOT FOF	11438	12-17-86	9:28a	Fresno
ARBDICOT BAB	24738	12-17-86	9:28a	Bakersfield
ARBDICOT LNX	23940	12-17-86	9:28a	Lancaster
ARBDICOT RSL	22078	12-17-86	9:28a	Riverside
ARBDICOT CLX	36708	12-17-86	9:28a	China Lake
ARBDICOT GLL	48412	12-17-86	9:28a	Glendora
ARBDICOT RUL	11970	12-17-86	9:28a	Rubidoux
ARBDICOT YCX	43890	12-17-86	9:28a	Yuba City
ARBDICOT LBL	27930	12-17-86	9:28a	Long Beach
RECEPTOR UNC	384	10-19-87	2:26a	Measurement uncertainties/Detection limits
RECEPTOR EXE	36126	10-18-87	1:14a	Reformats data files for CMB
13 File(s) 974848 bytes free				

This example is applied to data from the Bakersfield-Chester site. The data file ARBDICOT.BAB must be transferred to the FACTOR directory. Return to the FACTOR directory:

```
C> CD ..\FACTOR
```

and retrieve the data file ARBDICOT.BAB with the batch command:

```
C> GETDICOT ARBDICOT.BAB
```

The batch file GETDICOT.BAT contains the one line command COPY ..\PARTDAT\%1, with the replaceable parameter %1 to be substituted with the name of the data file that is to be retrieved, as in the command as it is shown above. The computer will display the command as executed:

```
C> COPY ..\PARTDAT\ARBDICOT.BAB
```

Before running the BMDP factor analysis program, the program control data file must contain the desired title for output and the correct input data file name. Program control information for the fine and coarse fraction PCA's is contained in the file FACTOR.DAT, listed below. Brief descriptions of control statements are also shown. See the BMDP manual document "BMDP Statistical Software, 1983 Revised Printing", available from BMDP Statistical Software, Inc., for more complete explanations. That manual also describes numerous program options in addition to those used in this example. Commands shown below are also summarized in the BMDP document "BMDP User's Digest, Third edition", which is also available from BMDP Statistical Software. Both of these documents are provided with purchase of BMDP programs.

```

/PROBLEM TITLE IS '**** FINE ANALYSIS TITLE GOES HERE ****'
/INPUT VARIABLES ARE 34.
      FORMAT IS '(19X,A2,A4,12X,F4,15F6/37X,F4,15F6)'. (ARB DICOT.BAB data file format)
      FILE= '**** DATA FILE NAME GOES HERE ****'
/VARIABLE NAMES ARE DATE1,DATE2,CMASU,CBR,CPB,CCU,CZN,CNI,CTI,CV,CCR,CMN,
      CFE,CK,CCA,CSI,CCL,CSO4,FMASU,FBR,FPB,FCU,FZN,FNI,FTI,FV,FCR,
      FMN,FFE,FK,FCA,FSI,FCL,FSO4,CMAS,FMAS,CMASDF,FMASDF.

      LABELS ARE DATE1,DATE2. (Defines variables DATE1 and DATE2 to be labels
                                for printed information)
      ADD=4. (Variables created in the TRANS paragraph will
              automatically be named and added to the data file)
      USE=36,20 TO 33. (Variable numbers to use for fine fraction analysis)
/TRANS CMAS=1000 * CMASU. (Convert CMAS and FMAS, total coarse and total fine
      FMAS=1000 * FMASU. mass, to nanograms)
      CMASDF=CMAS-(CSO4). (Defines variables CMASDF and FMASDF to be total
      FMASDF=FMAS-(FSO4). mass minus sulfate)
/SAVE CODE=ARB. (A name that must be specified whenever the
                following data file is used as input)

      FILE='DICOTF.BMD'.
      NEW. (Save fine data in temporary file DICOTF.BMD)
      CONTENT=DATA.
      FORMAT=BMDP.

/FACTOR METHOD=PCA. (Parameters to define analysis: PCA on
      FORM=CORR. correlation matrix)
      NUMBER=4. (Use 4 factors)
      CONSTANT=0.0002 (Not used if NUMBER is defined)

/ROTATE METHOD=VMAX. (Use varimax method for rotating factors)

/PRINT CASE=0. NCUT=5.
      FSCORE=0.
      NO SHADE. (Output tables definitions)
      NO CORR.
      LEVEL=BRIEF.

/PLOT INIT=0. (Controls number of plots to be displayed.
      FINAL=0. No plots in this case.)
      FSCORE=0.

/END
/PROBLEM TITLE IS '**** COARSE ANALYSIS TITLE GOES HERE ****'.

/INPUT FILE IS'DICOTF.BMD'. (Input file for the coarse analysis, saved
      CODE=ARB. from the control parameter file for the
                        fine analysis)
/VARIABLE USE=35,4 TO 17. (Variable numbers for coarse fraction PCA)
/SAVE CODE=ARB.
      FILE='DICOTC.BMD'. (Save coarse data in file DICOTC.BMD)
      NEW.
      CONTENT=DATA.
      FORMAT=BMDP.

```



```

/FACTOR
    METHOD=PCA.
    FORM=CORR.
    NUMBER=4.
        CONSTANT=0.002
/ROTATE
    METHOD=VMAX.
/PRINT
    CASE=0. NCUT=5.
    FSCORE=0.
    NO CORR.
    NO SHADE.
    LEVEL=BRIEF.
/PLOT
    INIT=0.
    FINAL=0.
    FSCORE=0.
/END

```

There are three fields to be edited in this file: two title fields and one particulate data file name field. These fields are blocked out in the control parameter data file listing above. Edit this file with the Zenword text editor (or other editor). Edit the above file with Zenword by typing:

```
C> ZW FACTOR.DAT
```

and using appropriate edit commands. A brief description of the Zenword text editor is contained in section 2.2.6 of this document. For this example application, change the title to BAKERSFIELD FINE PARTICLE PCA for the fine fraction analysis, and to BAKERSFIELD COARSE PARTICLE PCA for the coarse fraction analysis. Insert the particulate data file name, ARBDICOT.BAB, in place of the string "DATA FILE NAME GOES HERE".

With the ARBDICOT.BAB data file in the FACTOR directory, and with the control parameter file FACTOR.DAT correctly edited, the factor analysis program 4M.86 may be executed. First, insert the BMDP Master Diskette into the floppy disk drive. To get a printing of factor analysis results as the analysis proceeds, type:

```
C> CTL-PRISC
```

i.e., hold these two keys down at the same time. At any time, automatic printing can be stopped by repeating the above command.

Now initiate program 4M execution with the BMDP command BMDPRUN 4M FACTOR.DAT [outfile]. The optional [outfile] is the name of an output file name where factor analysis results are to be stored, if desired. For this example, use FACTOR.LST as the name of the file for the list of program results, i.e., type:

```
C> BMDPRUN 4M FACTOR.DAT FACTOR.LST
```

When program 4M is initiated, the following system displays will appear:

```
C>ECHO OFF
```

```
BMDP Program Loader Version 4.2 20-Jul-84  
Available Memory Space = 578 Kbytes
```

```
C>4M(UNIT5=FACTOR.DAT)
```

The program will then display header and program control information for the fine fraction analysis:

PAGE 1 BMDP4M
BMDP4M - FACTOR ANALYSIS
BMDP STATISTICAL SOFTWARE, INC.
1964 WESTWOOD BLVD. SUITE 202
LOS ANGELES, CA 90025
(213) 475-5700
PROGRAM REVISED FOR PC VERSION MAY 1984
MANUAL REVISED -- 1983
COPYRIGHT (C) 1983 REGENTS OF UNIVERSITY OF CALIFORNIA

TO SEE REMARKS AND A SUMMARY OF NEW FEATURES FOR
THIS PROGRAM, STATE NEWS. IN THE PRINT PARAGRAPH.

03/08/87 AT 12:35:17

PROGRAM CONTROL INFORMATION

/PROBLEM TITLE IS 'BAKERSFIELD FINE PARTICLE PCA'.
/INPUT VARIABLES ARE 34.
FORMAT IS '(19X,A2,A4,12X,F4,15F6/37X,F4,15F6)'.
FILE='ARBDICOT.BAB'.
/VARIABLE NAMES ARE DATE1,DATE2,CMASU,CBR,CPB,CCU,CZN,CNI,CTI,CV,CCR,CMN,
CFE,CK,CCA,CSI,CCL,CSO4,FMASU,FBR,FPB,FCU,FZN,FNI,FTI,FV,FCR,
FMN,FFE,FK,FCA,FSI,FCL,FSO4,CMAS,FMAS,CMASDF,FMASDF.
LABELS ARE DATE1,DATE2.
ADD=4.
USE=36,20 TO 33.
/TRANS CMAS=1000 * CMASU.
FMAS=1000 * FMASU.
CMASDF=CMAS-(CSO4).
FMASDF=FMAS-(FSO4).
/SAVE CODE=ARB.
FILE='DICOTF.BMD'.
NEW.
CONTENT=DATA.
FORMAT=BMDP.
/FACTOR
METHOD=PCA.
FORM=CORR.
NUMBER=4.
CONSTANT=0.0002
/ROTATE
METHOD=VMAX.
/PRINT CASE=0. NCUT=5.
FSCORE=0.
NO SHADE.
NO CORR.
LEVEL=BRIEF.
/PLOT INIT=0.
FINAL=0.
FSCORE=0.
/END

This display is followed by additional program control information, including the number of cases read and the number used, as follows:

PAGE 2 BMDP4M BAKERSFIELD FINE PARTICLE PCA

REQUESTED OUTPUT BMDP FILE

UNIT = 8

CODE = ARB

LABEL = 03/08/87 14:29:19

CONTENT =

DATA (INPUT DATA MATRIX AND FACTOR SCORES)

BASED ON INPUT FORMAT SUPPLIED 2 RECORDS READ PER CASE.

NUMBER OF CASES READ	93
CASES WITH DATA MISSING OR BEYOND LIMITS . .	9
REMAINING NUMBER OF CASES	84

The above display should be reviewed to ensure that an adequate number of cases were used in the analysis. In this example, a total of 93 cases were read. Of these, 84 were used. The remaining 9 were deleted from the analysis because of incomplete data sets or data with out-of-limit values. (4M requires all requested variables to be present in each sample used). The number of cases used, 84, is adequate with respect to stability of the factors. Repeat analyses, using random subsets from the complete sample data set, may be used to test stability of factors from the PCA if the number of cases used is much less than about 80.

The remainder of analysis output consists of factor analysis results. For this example, brief discussions of each analysis page are presented. More detailed explanations of program results may be found on pages 480-499 of the BMDP manual. Additional tutorials may be found in the BMDPC User's Guide document, also cited previously.

The next display presents summary statistics for each variable used in the analysis. This table should be reviewed for reasonability and for evidence of extreme values and outliers. As shown, many of the variables used are highly variable and have standard deviations that are very large with respect to their mean values:

STATISTICS FOR EACH VARIABLE

VARIABLE	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION	SMALLEST VALUE	SMALLEST STANDARD CASE FOR SCORE	FIRST SMALLEST	LARGEST VALUE	LARGEST STANDARD CASE FOR SCORE	FIRST LARGEST
36 FMS	22904.76190	15154.32186	0.661623	5000.0000	-1.18	9	72000.0000	3.24	40
20 FBR	53.75000	44.41260	0.826281	8.0000	-1.03	10	259.0000	4.62	40
21 FPB	205.09524	114.66542	0.559084	39.0000	-1.45	10	678.0000	4.12	40
22 FCU	8.85714	12.72900	1.43715	0.0000	-0.70	2	109.0000	7.87	75
23 FZN	12.66667	12.13313	0.957879	0.0000	-1.04	1	54.0000	3.41	90
24 FNI	24.32143	23.58740	0.969820	1.0000	-0.99	18	165.0000	5.96	92
25 FTI	7.73810	7.20953	0.931706	1.0000	-0.93	8	44.0000	5.03	77
26 FV	15.19048	12.82174	0.844064	1.0000	-1.11	18	89.0000	5.76	92
27 FCR	1.19048	1.01169	0.849822	0.0000	-1.18	1	5.0000	3.77	57
28 FMN	3.45238	2.35113	0.681018	0.0000	-1.47	8	13.0000	4.06	85
29 FFE	129.32143	101.72478	0.786604	34.0000	-0.94	43	578.0000	4.41	77
30 FK	162.11905	149.13279	0.919897	19.0000	-0.96	11	1137.0000	6.64	70
31 FCA	66.90476	53.96153	0.806542	8.0000	-1.09	42	313.0000	4.56	77
32 FSI	582.26190	414.64225	0.712123	188.0000	-0.95	42	2555.0000	4.76	77
33 FCL	77.78571	96.59493	1.24181	12.0000	-0.68	12	617.0000	5.68	39

CASE NUMBERS ABOVE REFER TO DATA MATRIX BEFORE ANY CASES
HAVE BEEN DELETED DUE TO MISSING DATA.
CASES WITH ZERO WEIGHTS ARE NOT INCLUDED.

The next table gives the Squared Multiple Correlations (SMC) of each variable with all other variables. The condition number is the ratio of the largest eigenvalue to the smallest eigenvalue and is of interest to see how nearly singular the correlation matrix is. The condition number is not of importance in a Level I Assessment.

PAGE 4 BMDP4M BAKERSFIELD FINE PARTICLE PCA

SQUARED MULTIPLE CORRELATIONS (SMC) OF
EACH VARIABLE WITH ALL OTHER VARIABLES

36 FMAS	0.89976
20 FBR	0.90246
21 FPB	0.89730
22 FCU	0.46664
23 FZN	0.62288
24 FNI	0.98927
25 FTI	0.91329
26 FV	0.98929
27 FCR	0.41685
28 FMN	0.72658
29 FFE	0.83579
30 FK	0.62794
31 FCA	0.91839
32 FSI	0.88332
33 FCL	0.71901

CONDITION NUMBER = 989.1

The next table shows the communalities for each of the variables, obtained from the 4 factors requested. This is similar to the previous display, except that communalities are the squared multiple correlations of the variables with the derived factors, rather than with the other variables:

PAGE 5 BMDP4M BAKERSFIELD FINE PARTICLE PCA

COMMUNALITIES OBTAINED FROM 4 FACTORS AFTER 1 ITERATIONS.

THE COMMUNALITY OF A VARIABLE IS ITS SQUARED MULTIPLE
CORRELATION WITH THE FACTORS.

36 FMAS	0.9003
20 FBR	0.8948
21 FPB	0.8483
22 FCU	0.6764
23 FZN	0.6121
24 FNI	0.9584
25 FTI	0.9209
26 FV	0.9599
27 FCR	0.5133
28 FMN	0.7265
29 FFE	0.8523
30 FK	0.4284
31 FCA	0.9226
32 FSI	0.8584
33 FCL	0.6972

The next table gives the proportion of the variance explained (the eigenvalue) for each factor, and the cumulative proportion of the total variance explained. In this example, it shows that most (.7847) of the total variance is explained by the first four factors:

PAGE 6 BMDP4M BAKERSFIELD FINE PARTICLE PCA

FACTOR	VARIANCE EXPLAINED	CUMULATIVE PROPORTION OF VARIANCE		CARMINES' THETA
		IN DATA SPACE	IN FACTOR SPACE	
1	5.2891	0.3526	0.4494	0.8689
2	3.5936	0.5922	0.7547	
3	1.7813	0.7109	0.9060	
4	1.1059	0.7847	1.0000	
5	0.8228	0.8395		
6	0.6844	0.8851		
7	0.5523	0.9220		
8	0.3939	0.9482		
9	0.3337	0.9705		
10	0.1671	0.9816		
11	0.1078	0.9888		
12	0.0676	0.9933		
13	0.0489	0.9966		
14	0.0463	0.9996		
15	0.0053	1.0000		

THE VARIANCE EXPLAINED BY EACH FACTOR IS THE EIGENVALUE FOR THAT FACTOR (IF POSITIVE).

TOTAL VARIANCE IS DEFINED AS THE SUM OF THE POSITIVE EIGEN VALUES OF THE CORRELATION MATRIX.

The next three tables show the Unrotated Factor Loadings (Output Page 7), the Rotated Factor Loadings (Page 8), and the Sorted Rotated Factor Loadings (Page 9):

PAGE 7 BMDP4M BAKERSFIELD FINE PARTICLE PCA
UNROTATED FACTOR LOADINGS (PATTERN)

FOR PRINCIPAL COMPONENTS

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
FMAS	36	0.782	-0.486	-0.109	0.201
FBR	20	0.528	-0.548	-0.515	-0.224
FPB	21	0.556	-0.449	-0.499	-0.298
FCU	22	0.353	-0.097	0.261	0.689
FZN	23	0.676	-0.215	-0.208	0.256
FNI	24	0.316	-0.584	0.643	-0.324
FTI	25	0.549	0.772	0.003	-0.153
FV	26	0.347	-0.583	0.603	-0.368
FCR	27	0.555	-0.074	0.403	0.193
FMN	28	0.835	0.116	0.081	0.096
FFE	29	0.776	0.436	0.235	-0.070
FK	30	0.501	0.288	-0.301	-0.066
FCA	31	0.591	0.737	0.145	-0.094
FSI	32	0.669	0.612	-0.073	-0.174
FCL	33	0.577	-0.558	-0.158	0.167
VP		5.289	3.594	1.781	1.106

THE VP FOR EACH FACTOR IS THE SUM OF THE SQUARES OF THE
ELEMENTS OF THE COLUMN OF THE FACTOR LOADING MATRIX
CORRESPONDING TO THAT FACTOR. THE VP IS THE VARIANCE
EXPLAINED BY THE FACTOR.

ORTHOGONAL ROTATION, GAMMA = 1.0000

ITERATION	SIMPLICITY CRITERION
0	-2.159156
1	-6.921417
2	-6.958151
3	-6.958206
4	-6.958206

ROTATED FACTOR LOADINGS (PATTERN)

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
FMS	36	0.130	0.757	0.252	0.497
FBR	20	-0.015	0.936	0.102	-0.085
FPB	21	0.092	0.898	0.110	-0.144
FCU	22	0.033	0.019	0.023	0.821
FZN	23	0.233	0.603	0.006	0.441
FNI	24	-0.092	0.148	0.957	0.111
FTI	25	0.947	-0.080	-0.131	-0.015
FV	26	-0.064	0.194	0.955	0.072
FCR	27	0.301	0.096	0.389	0.512
FMN	28	0.626	0.362	0.183	0.413
FFE	29	0.857	0.083	0.213	0.255
FK	30	0.536	0.324	-0.189	0.006
FCA	31	0.946	-0.129	-0.026	0.100
FSI	32	0.915	0.124	-0.074	0.008
FCL	33	-0.053	0.710	0.209	0.383
VP		4.231	3.475	2.248	1.816

THE VP FOR EACH FACTOR IS THE SUM OF THE SQUARES OF THE
ELEMENTS OF THE COLUMN OF THE FACTOR PATTERN MATRIX
CORRESPONDING TO THAT FACTOR. WHEN THE ROTATION IS
ORTHOGONAL, THE VP IS THE VARIANCE EXPLAINED BY THE FACTOR.

SORTED ROTATED FACTOR LOADINGS (PATTERN)

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
FTI	25	0.947	0.000	0.000	0.000
FCA	31	0.946	0.000	0.000	0.000
FSI	32	0.915	0.000	0.000	0.000
FFE	29	0.857	0.000	0.000	0.255
FMN	28	0.626	0.362	0.000	0.413
FK	30	0.536	0.324	0.000	0.000
FBR	20	0.000	0.936	0.000	0.000
FPB	21	0.000	0.898	0.000	0.000
FMAS	36	0.000	0.757	0.252	0.497
FCL	33	0.000	0.710	0.000	0.383
FZN	23	0.000	0.603	0.000	0.441
FNI	24	0.000	0.000	0.957	0.000
FV	26	0.000	0.000	0.955	0.000
FCU	22	0.000	0.000	0.000	0.821
FCR	27	0.301	0.000	0.389	0.512
VP		4.231	3.475	2.248	1.816

THE ABOVE FACTOR LOADING MATRIX HAS BEEN REARRANGED SO THAT THE COLUMNS APPEAR IN DECREASING ORDER OF VARIANCE EXPLAINED BY FACTORS. THE ROWS HAVE BEEN REARRANGED SO THAT FOR EACH SUCCESSIVE FACTOR, LOADINGS GREATER THAN 0.5000 APPEAR FIRST. LOADINGS LESS THAN 0.2500 HAVE BEEN REPLACED BY ZERO.

The last table above, of Sorted Rotated Factor Loadings, is the most useful result from the PCA for a Level I Assessment. It shows how the factor loadings on each variable are grouped within each factor. In the example table, high loadings for each factor are blocked out. This information can be used to identify source types by the variables associated with these blocks. After some practice and familiarity with PCA and the chemical compositions of various source types, it is not difficult to associate these factors with sources. Identification of source types from the PCA may also be made by comparison of the above groups with chemical profiles of source categories found in the EPA Source Composition Library.

The PCA results shown above suggest that the fine fraction of PM10 concentrations at the Bakersfield-Chester site are influenced by the following source types:

Factor 1: Soil (geological, crustal) sources, characterized by Ti, Ca, Si, Fe, and K.

Factor 2: Motor vehicle sources, characterized by Br, Pb, and Cl. Zn, which also appears with Factor 2, may indicate that road dust has also been included in this factor, i.e., there may actually be two sources that are operationally linked.

Factor 3: Residual Oil, characterized by V and Ni.

Factor 4: Metal Operations, dominated by Cu.

It should be noted that Factor 4, dominated by Cu but also including other metallic elements (Mn, Fe, Zn), also suggests that sampler motor operation could be interfering with particulate samples. Metal operations are not clearly identified as major emitters in the Kern County emissions inventory, and this may be the case. It should also be noted here that additional analyses for other PM10 components could show additional factors. For example, inclusion of nitrate, ammonium, and carbons (organic and/or elemental) in chemical analyses may have yielded a secondary aerosol factor. In using this analysis, the variables included, and those not included, must be kept in mind, as well as the types of sources actually present in the area that could contribute to PM-10 concentrations measured at the sampler site. The BMDP program used here can be modified to rotate a larger or smaller number of factors, or to derive factors from subsets of the data. Such tests may be performed, and should be performed in a Level II Assessment, to verify the signatures and the stability of the sources that have been identified.

The last table from the fine fraction analysis gives a matrix of the Factor Score Covariances. The diagonal of the covariance matrix contains the squared multiple correlations of each factor with the variables. This matrix is the identity matrix. Any diagonal values not equal to one in this matrix are indications that there may be problems with collinearity:

PAGE 10 BMDP4M BAKERSFIELD FINE PARTICLE PCA

FACTOR SCORE COVARIANCE (COMPUTED FROM FACTOR
STRUCTURE AND FACTOR SCORE COEFFICIENTS)

THE DIAGONAL OF THE MATRIX BELOW CONTAINS THE SQUARED
MULTIPLE CORRELATIONS OF EACH FACTOR WITH THE VARIABLES.

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
FACTOR 1	1.000			
FACTOR 2	-0.000	1.000		
FACTOR 3	0.000	0.000	1.000	
FACTOR 4	-0.000	0.000	0.000	1.000

The final table produced by the fine fraction analysis, with the control parameters specified in the control data file FACTOR.DAT, gives program execution summary information:

BMDP FILE DICOTF.BMD
IS BEING WRITTEN ON UNIT 8
CODE . . . IS ARB
CONTENT . IS DATA
LABEL . . IS
03/08/87 12:35:17

BMDP FILE DICOTF.BMD
ON UNIT 8 HAS BEEN COMPLETED.

NUMBER OF CASES WRITTEN TO FILE 93

With the control parameters as used in this example, PCA is performed for the coarse fraction immediately following the analysis for the fine fraction. All of the analyses presented above are repeated for variable species in the coarse fraction of PM-10 samples. The same tables are thus repeated and are not shown here except for the Sorted Rotated Factor Loadings:

PAGE 18 BMDP4M BAKERSFIELD COARSE PARTICLE PCA

SORTED ROTATED FACTOR LOADINGS (PATTERN)

		FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
CK	14	0.974	0.000	0.000	0.000
CTI	9	0.973	0.000	0.000	0.000
CSI	16	0.973	0.000	0.000	0.000
CFE	13	0.970	0.000	0.000	0.000
CMN	12	0.969	0.000	0.000	0.000
CMAS	35	0.945	0.000	0.000	0.000
CCR	11	0.866	0.000	0.000	0.000
CCA	15	0.579	0.000	0.000	0.000
CPB	5	0.000	0.973	0.000	0.000
CBR	4	0.000	0.943	0.000	0.000
CZN	7	0.424	0.616	0.465	0.000
CCL	17	0.000	0.000	0.732	0.000
CCU	6	0.000	0.271	0.669	0.389
CV	10	0.410	0.000	0.000	0.749
CNI	8	-0.498	0.000	0.000	0.711
VP		7.381	2.524	1.366	1.342

THE ABOVE FACTOR LOADING MATRIX HAS BEEN REARRANGED SO THAT THE COLUMNS APPEAR IN DECREASING ORDER OF VARIANCE EXPLAINED BY FACTORS. THE ROWS HAVE BEEN REARRANGED SO THAT FOR EACH SUCCESSIVE FACTOR, LOADINGS GREATER THAN 0.5000 APPEAR FIRST. LOADINGS LESS THAN 0.2500 HAVE BEEN REPLACED BY ZERO.

Here the same factors appear that appeared in the fine fraction analysis, except that the residual oil factor (V, NI) and the metal operations factor (CI, Cu) are reversed. Also, the amount of the coarse fraction variance explained by the soil factor (Factor 1) is more than was the amount of the fine fraction variance explained by the soil factor.

The PCA ends with program termination information:

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BMDP4M - FACTOR ANALYSIS

03/08/87 AT 12:37:15

PROGRAM CONTROL INFORMATION

NO MORE CONTROL LANGUAGE.

PROGRAM TERMINATED

This concludes the Phase I - Source Type Identification portion of the example. To summarize results from this example, considering the chemical species included in the sample analyses:

1. Principal Components Analysis confirms, within the limits of what was measured, that PM-10 samples from the Bakers-field-Chester site have major contributions from geological (e.g. soil) sources, motor vehicle sources, and residual oil combustion. These sources are consistent with the Kern County emissions inventory.
2. One type of source was identified that was not found in the emissions inventory. This was a metallurgical source. (The greatest value of PCA is its ability to identify un-inventoried sources).
3. With more complete measurements, including for example nitrates, sulfates, ammonium, and organic materials, additional factors may have been identified. (This is quite possible, as a review of the emissions inventory showed that sources characterized by these species exist).

These results indicate that for the next phase, Phase II - Source Type Apportionment using the Chemical Element Balance Model, sources of the types identified above should be taken from the EPA Source Composition Library and used. Sources included in the ARB emissions inventory suggest that vegetative burning and secondary types of sources should also be included.

4.3 Phase II - Source Type Apportionment

This phase uses the CMB (Chemical Mass Balance) model to apportion measured PM-10 concentrations for a specific day to various source type categories. CMB programs are contained in the directory CMB. To get into the CMB directory, enter:

```
C> CD ..\CMB
```

Type

```
C> DIR
```

to view directory contents:

Volume in drive C is id1v1

Directory of C:\PM10\CMB

.	<DIR>	10-12-87	1:23p	
..	<DIR>	10-12-87	1:23p	
SOCARB	DAT	256	1-02-80 3:34a	Source names input file for CMB
GETDCARB	BAT	128	1-01-80 12:08a	Retrieves ambient data file (DACARB.DAT) from PARTDAT
GETSCARB	BAT	128	1-01-80 12:11a	Retrieves source data files (FSCARB.DAT and CSCARB.DAT) from SOURCLIB
CMB6	EXE	258526	7-20-87 7:01a	CMB model, Version 6
POCARB	DAT	384	1-01-80 3:05a	Chemical species codes input file for CMB
INCARB	DAT	128	1-01-80 2:54a	List of names of CMB input data files
8 File(s) 1832960 bytes free				

The CMB model is applied to data sets consisting of:

1. Ambient particulate measurements from the site being analyzed for the day selected.
2. Source category information from the EPA Source Library that includes chemical characterizations for each source type.

These data sets are contained in directories PARTDAT and SOURCLIB, respectively. Directory contents for directory PARTDAT were described in the previous section. The PARTDAT directory file required by CMB is DACARB.DAT. This file is created, in PARTDAT, using the executable program RECEPTOR. To execute this program, use the batch file GETDCARB.BAT. Enter:

```
C> GETDCARB
```


This batch file contains a series of commands to direct the computer to enter the PARTDAT directory, execute the program RECEPTOR to read the appropriate CARB particulate data file and reformat it for use in the CMB model, return to the CMB directory, and retrieve the CMB input file DACARB.DAT created during execution. When RECEPTOR is initiated, the first prompt is:

What is the name of your input file?

At this prompt, enter the desired ARB data file name. Particulate data files are of the form ARBDICOT.iii, where iii is as shown in Table 3.3-1. For this example, enter the name of the Bakersfield-Chester site:

ARBDICOT.BAB

The next prompt is:

What is the name of your output file?

Respond with the name of the required CMB ambient data file name, DACARB.DAT. Type:

DACARB.DAT

The computer will display the uncertainties and detection limits that will be included in DACARB.DAT:

#	EL	UNC-FINE	DET-FINE	UNC-COAR	DET-COAR
1	TM	10.00000	.01000	10.00000	.01000
2	BR	10.00000	.01000	10.00000	.01000
3	PB	10.00000	.01000	10.00000	.01000
4	CJ	10.00000	.01000	10.00000	.01000
5	ZN	10.00000	.01000	10.00000	.01000
6	NI	10.00000	.01000	10.00000	.01000
7	TI	10.00000	.01000	10.00000	.01000
8	V	10.00000	.01000	10.00000	.01000
9	CR	10.00000	.01000	10.00000	.01000
10	MN	10.00000	.01000	10.00000	.01000
11	FE	10.00000	.01000	10.00000	.01000
12	K	10.00000	.05000	10.00000	.05000
13	CA	10.00000	.05000	10.00000	.05000
14	SI	10.00000	.02000	10.00000	.02000
15	CL	10.00000	.05000	10.00000	.05000
16	S	10.00000	.13000	10.00000	.13000

Listed above are the default uncertainties in percent and the default detection limits in micrograms per cubic meter. To change a row enter the row number. To continue the program enter a 0(zero)

Follow the instructions shown to change any of the displayed default uncertainties and/or detection limits. Otherwise, enter

0

The program will take awhile to execute. At the end of execution, the computer will display:

Stop - Program terminated.

The created file DACARB.DAT will then be copied into the CMB directory.

The next data files required by the CMB model are FSCARB.DAT and CSCARB.DAT. These files contain source profiles for the fine and coarse particle fractions, respectively, and are created in the directory SOURCLIB. View the contents of the SOURCLIB directory by typing:

C> CD ..\SOURCLIB

to enter the SOURCLIB directory, and

```
C> DIR
```

for a directory listing. SOURCLIB directory contents are as follows:

```
Volume in drive C is fd1v1
Directory of C:\PM10\SOURCLIB
```

.	<DIR>	10-12-87	1:19p	
..	<DIR>	10-12-87	1:19p	
T90000	PRN	3968	10-18-87	3:44a
T13501	PRN	3968	4-14-86	10:54a
T21101	PRN	3456	4-14-86	11:55a
T21102	PRN	3456	4-14-86	11:59a
T21103	PRN	3968	4-14-86	12:03p
T33003	PRN	3968	4-15-86	9:37a
T41101	PRN	3968	4-15-86	1:46p
T41102	PRN	3968	4-15-86	1:49p
T41103	PRN	3968	4-15-86	1:52p
T41107	PRN	3968	4-15-86	2:05p
T41109	PRN	3968	4-15-86	2:08p
T42303	PRN	3968	4-16-86	11:17a
T42301	PRN	3840	4-16-86	11:11a
T42304	PRN	3968	4-16-86	11:21a
SOURCE	EXE	37728	10-18-87	7:59a
SOURCE	DAT	384	10-19-87	3:31a
18 File(s) 1867776 bytes free				

} Data files Tnnnnn.PRN are EPA Source Composition Library files. nnnnn is the code used to identify source profiles in the EPA document "Receptor Model Source Composition Library".

Input file for SOURCE
Reformats source profile data for CMB

Files with names Tnnnnn.PRN are EPA Source Library files. Descriptions for these files can be found in the document "Receptor Model Source Composition Library" and are identified in that document by the nnnnn number code. The program SOURCE converts data in the Source Library files to formats required by CMB. The data file SOURCE.DAT contains information used by SOURCE to select and reformat Source Library files. After viewing the contents of directory SOURCLIB, return to the CMB directory with the command:

```
C> CD ..\CMB
```

Data files FSCARB.DAT and CSCARB.DAT may now be created and retrieved from the SOURCLIB directory with the batch file GETSCARB.BAT. Execute the batch file by typing:

```
C> GETSCARB
```

This batch file contains a series of commands that will direct the computer to enter the SOURCLIB directory, execute the program SOURCE to create FSCARB.DAT and CSCARB.DAT, and copy them into the CMB directory. When SOURCE is executed, the computer will first respond with the following header display and prompt:

```
*****
*
*               U. S. EPA SOURCE SELECTOR PROGRAM
*          *** IBM-PC VERSION 1.0 (REVISED 8/11/87) ***
*
*   EPA PROJECT MGR: THOMPSON G. PACE III, PE
*                   U.S. ENVIRONMENTAL PROTECTION AGENCY
*                   OFFICE OF AIR QUALITY PLANNING AND STANDARDS
*                   RESEARCH TRIANGLE PARK, NC
*                   (919)-541-5585
*
*
*   PRINCIPAL AUTHOR:  DR. NORMAN F. ROBINSON
*                     DESERT RESEARCH INSTITUTE
*                     UNIVERSITY OF NEVADA SYSTEM
*                     (702)-972-1676
*
*   CONTRIBUTING AUTHORS:
*   DR. J.C. CHOW      MR. D.L. FREEMAN      MR. T.G. PACE
*   DR. J.G. WATSON
*
*****
```

ENTER NAME OF INPUT FILE

The input file for this example is SOURCE.DAT, which contains the EPA source profile codes for source categories to be included in the CMB model. (To include additional source profiles besides those used in this example and presently contained in the SOURCLIB directory, the SOURCE.DAT file must be edited to include the new source profile codes, and the Source Library files must be added to this directory). In response to the query at the end of the preceding display, enter:

SOURCE.DAT

The following display, which lists the names of the output files that will be created and the Source Library and element codes that will be included, will now appear on the terminal screen:

INFO IN FILE: SOURCE.DAT

FINE SOURCE OUTPUT FILE = FSCARB.DAT
COARSE SOURCE OUTPUT FILE = CSCARB.DAT

LIBRARY SOURCES =

T13501.PRN	T21101.PRN	T21102.PRN	T21103.PRN	T33003.PRN
T41101.PRN	T41102.PRN	T41103.PRN	T41107.PRN	T41109.PRN
T42303.PRN	T42301.PRN	T42304.PRN	T90000.PRN	

ELEMENT CODES =

35 82 29 30 28 22 23 24 25 26 19 20 14 17 16

Pause - Please enter a blank line (to continue) or a DOS command.

Press <enter> for the next display:

TABLE OF MISSING DATA DEFAULTS
(c and u represent valid data)

EPA LIBRARY		CMB PROFILE		FLAG
CONC	UNC	CONC	UNC	
NA OR NR		9999999.	0.	W
c	NR	.01c	.005c	X
<	u	0.	.01u	Y
<	NR	0.	.001	Z

Pause - Please enter a blank line (to continue) or a DOS command.

This table explains flags (W,X,Y,Z) that appear in data files FSCARB.DAT and CSCARB.DAT. The W flag means that, for a given source profile, information on a particular species was unavailable because it was either Not Analyzed (NA) or Not Reported (NR). In these cases the species concentration is defaulted to 9999999, which will intentionally cause the CMB model to terminate. The X flag means that an uncertainty value was not available for a given species having a valid concentration. In these cases, the uncertainty is defaulted to a value of .005c, where c is the species' percent composition.

(c is given as a percentage in the Source Library files. SOURCE converts percentages to fractional units for CMB input). The Y flag means that a particular species concentration was reported in the source profile as being less than detection limits, but was given a valid concentration uncertainty. In these cases, the species concentration is defaulted, for use in the CMB model, to 0, and the uncertainty is defaulted to .01u where u is the reported percentage uncertainty. The Z flag means that a species concentration was reported as being less than detection limits, with no uncertainty given. For these cases, the concentration is defaulted to 0 with an uncertainty of 0.001.

Press <enter> to give the next display:

SPECIES WITH NO DATA AVAILABLE		
SOURCE	SPECIES	SIZE
3	23	C

Stop - Program terminated.

This display will be shown if a requested source is found that is missing one or more of the requested species. In the above example, requested source number 3 (T21101.PRN, primary lead smelting, ore concentrate) had no information on requested species code 23 (V, Vanadium), for the coarse (C) size fraction.

After execution of SOURCE, the new data files FSCARB.DAT and CSCARB.DAT will be copied into the CMB directory. At the end of this process, the computer will display the lines:

```
..\SOURCELIB\FSCARB.DAT
..\SOURCELIB\CSCARB.DAT
  2 File(s) copied
```

A portion of the FSCARB.DAT data file that was created in this process, the source 2 (LIMEDUST) fine fraction profile, is shown below. It includes species codes, fractional compositions and associated uncertainties, species symbols, and default flags:

2	14	.064960	.006500	SI	LIMEDUST	
2	16	.010230	.001040	S		
2	17	.004550	.000480	CL		
2	19	.001630	.000420	K		
2	20	.295150	.029510	CA		
2	22	.000810	.000405	TI		X
2	23	.000000	.001000	V		Z
2	24	.000000	.001000	CR		Z
2	25	.000500	.000250	MN		X
2	26	.010430	.001040	FE		
2	28	.000000	.001000	NI		Z
2	29	.000160	.000080	CU		X
2	30	.001040	.000100	ZN		
2	35	.000270	.000135	BR		X
2	82	.002700	.000270	PB		

Before running the CMB model, it is a good idea to review CMB source input files for default flags.

All required files now reside in the directory CMB and the CMB model may be executed. Before beginning a CMB model run, it is sometimes helpful to have successive computations routed to the line printer. This is so that previous tables can be referred to as different sources and species are tried. By having previous results available for review, it is easier to see if additions and deletions of sources and species have the effect of improving or degrading the fit. Initiate continuous line printer display of results by entering:

```
C> CTL-PRTSC
```

Hold these keys down simultaneously. The line printer can be removed from continuous operation at any time by re-entering the above command.

Begin CMB execution by entering:

```
C> CMB6
```

This will initiate a series of queries at the terminal screen. The first display is:

MAKE SURE THAT YOUR CAPS LOCK IS ON ! ! !

DISK FILE FOR INITIAL INPUT?
IF NOT ENTER CARRIAGE RETURN
IF SO ENTER NAME OF DISK FILE

The name of the file containing initial input is INCARB.DAT. This file contains the names of all other files used as input to the CMB model. CMB file names are of the form iiCARB.DAT, as described in the CMB User's Guide. Enter:

INCARB.DAT

The next query is:

DO YOU WISH TO RENAME CMBOUT?
IF NOT ENTER A CARRIAGE RETURN.
IF SO ENTER THE FILE NAME.

Respond with the name of the list file for CMB model results. For this example, the name is CMB.LST.
Enter:

CMB.LST

A header will be displayed at the terminal screen:

```
*****
*
*      U. S. EPA CHEMICAL MASS BALANCE RECEPTOR MODEL
*      *** IBM-PC VERSION 6.0 (REVISED 7/20/87) ***
*
*      EPA PROJECT MGR: THOMPSON G. PACE III, PE
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*
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and after a few moments:

THE "HELP" COMMAND LISTS COMMANDS.
USE COMMANDS AE,DE,AS,DS FOR CHANGES.
ENTER COMMAND

At any point in the CMB session, the HELP file may be called by entering:

HELP

This will provide the following display:

HELP-LISTS THESE COMMANDS

—— DATA ACCESS AND SEQUENCING ——
SELECT-SELECT DATA SET FOR CMB
SIZE-CHANGE SIZE FRACTION
EXIT-CLOSE FILES AND LEAVE

—— CMB OPERATIONS ——
AE-ADD A POLLUTANT TO THE FIT
DE-DELETE A POLLUTANT FROM THE FIT
AS-ADD A SOURCE TO THE FIT
DS-DELETE A SOURCE FROM THE FIT
CMB-PERFORM CMB

Pause.

Please press <return> to continue.

Press <enter> to continue the display:

—— SCREEN DISPLAY ——
PINFO - PRINT CURRENT STATUS ON SCREEN
PMATRIX - PRINT SOURCE SIGNATURE OR RECEPTOR CONCENTRATIONS
SSCONT - PRINT SOURCE CONTRIBUTIONS TO ELEMENTAL CONCS. TO SCREEN
PCOMP - PRINT COMPUTED AVERAGES OF CMB SERIES

—— DATA STORAGE ——
WRITE - WRITE CMB RESULTS TO DISK

SELECT SHOULD NORMALLY BE THE FIRST COMMAND
ENTER COMMAND

At this prompt, enter:

SELECT

This initiates a sequence of prompts and queries concerning site name, sample day to be analyzed, and particle size fraction desired. This example is for Bakersfield-Chester for June 17, 1983.

To the prompt:

ENTER DESIRED CMB SITE CODE: XXXXXXXXXXXX

Respond with:

ARBAB14

To the prompt:

ENTER YEAR: YY

Respond with:

83

To the prompt:

ENTER DATE: MMDD

Respond with:

0617

To the prompt:

INPUT DESIRED SIZE FRACTION:(FINE OR COARSE)

Respond with:

FINE

The computer will restate the day requested and will search for it in data file DACARB.DAT. As it searches, it will display successive dates encountered until it locates the date sought:

DATA SEARCH BEGUN FOR

SITE: ARBAB14

YEAR: 83 DATE: 0617

SITE: ARBAB14	YEAR: 83 DATE: 0307	FC
SITE: ARBAB14	YEAR: 83 DATE: 0313	FC
SITE: ARBAB14	YEAR: 83 DATE: 0317	FC
SITE: ARBAB14	YEAR: 83 DATE: 0319	FC
SITE: ARBAB14	YEAR: 83 DATE: 0325	FC
SITE: ARBAB14	YEAR: 83 DATE: 0331	FC
SITE: ARBAB14	YEAR: 83 DATE: 0406	FC
SITE: ARBAB14	YEAR: 83 DATE: 0412	FC
SITE: ARBAB14	YEAR: 83 DATE: 0418	FC
SITE: ARBAB14	YEAR: 83 DATE: 0424	FC
SITE: ARBAB14	YEAR: 83 DATE: 0430	FC
SITE: ARBAB14	YEAR: 83 DATE: 0506	FC
SITE: ARBAB14	YEAR: 83 DATE: 0512	FC
SITE: ARBAB14	YEAR: 83 DATE: 0518	FC
SITE: ARBAB14	YEAR: 83 DATE: 0524	FC
SITE: ARBAB14	YEAR: 83 DATE: 0530	FC
SITE: ARBAB14	YEAR: 83 DATE: 0605	FC
SITE: ARBAB14	YEAR: 83 DATE: 0611	FC
SITE: ARBAB14	YEAR: 83 DATE: 0617	FC

ENTER COMMAND

The remainder of the example in this section is intended to provide familiarity with the commands and displays used in the CMB model. Additional explanations of commands and displays can also be found in the EPA document "Revised CMB User's Manual".

Respond to the "ENTER COMMAND" prompt at the end of the previous display with the command for execution of the CMB model:

CMB

The first display gives the Source Contribution Table from initial fit data indicated by asterisks in appropriate fields of the POCARB.DAT and SOCARB.DAT data files:

SOURCE CONTRIBUTION ESTIMATES - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0
 SAMPLE DURATION 24 START HOUR 0 SIZE: FINE
 R SQUARE .96 PERCENT MASS 63.7
 CHI SQUARE .96 DF 10

SOURCE			
* TYPE	SCE(UG/M3)	STD ERR	TSTAT
1 ROILCMB	.1790	.1824	.9813
5 TRANCM79	1.1056	.1904	5.8062
9 PRDPRTOR	4.7013	.4642	10.1288
13 AGRFLDBN	4.3752	1.7199	2.5438
14 SULFATE	3.6512	.5586	6.5357

MEASURED CONCENTRATION FINE/COARSE/TOTAL:
 22.0+- 2.2/ 89.0+- 8.9/ 111.0+- 9.2
 Pause.
 Please press <return> to continue.

This table shows very reasonable values for the R SQUARE and CHI SQUARE statistics with 63.7% of the fine particle mass accounted for. The standard errors are mostly reasonable, although the standard error (uncertainty) for the residual oil source contribution (ROILCMB) is high with respect to the Source Contribution Estimate (SCE).

To see the next display, press <enter>. The computer responds with:

Pause.

Please press <return> to continue.

The absence of Uncertainty/Similarity Clusters indicates that the uncertainties in the individual source profiles are not too large for valid CMB results, and that the collinearity is within acceptable limits.

To see the next display, press <enter>. The computer responds with the Species Concentrations Table:

SPECIES CONCENTRATIONS - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0
 SAMPLE DURATION 24 START HOUR 0 SIZE: FINE
 R SQUARE .96 PERCENT MASS 63.7
 CHI SQUARE .96 DF 10

SPECIES-I-M	MEAS	CALC	RATIO C/M	RATIO R/U
1 TOT	22.0000+-	2.20000	14.01223+-	1.73476
35 BR *	.04800+-	.01000	.05756+-	.01888
82 PB *	.25700+-	.02570	.24002+-	.03395
29 CU *	.00700<	.01000	.00716<	.01751
30 ZN *	.00800<	.01000	.00976<	.00614
28 NI *	.01200+-	.01000	.01022+-	.00610
22 TI *	.01500+-	.01000	.03050+-	.00575
23 V *	.00800<	.01000	.00724<	.00586
24 CR *	.00300<	.01000	.00242<	.00086
25 MN *	.00500<	.01000	.00604<	.00085
26 FE *	.24800+-	.02480	.31936+-	.03955
19 K *	.41200+-	.05000	.30786+-	.10942
20 CA *	.18000+-	.05000	.14886+-	.02362
14 SI *	1.27300+-	.12730	1.07230+-	.05256
17 CL *	.03100<	.05000	.16880<	.08820
16 S *	1.32830+-	.13280	1.32830+-	.12574

ENTER COMMAND

This final table, the Species Concentrations table, shows that the ratios of calculated to measured concentrations (C/M) for individual species are generally within the acceptable range of 0.5 to 2.0, with the exception of CL (5.45). However, also note that the amount of CL measured, .03100 micrograms per cubic meter, is less than the detection threshold, as indicated by the <. It might be desirable to delete CL from subsequent calculations. Ratios of residuals (calculated concentrations minus measured concentrations) to uncertainties, R/U, are generally reasonable. As a guideline, they should be less than 2.0 in absolute magnitude. The R/U ratio of -2.9 for the total fine mass indicates that a significant source may be missing. For this example, we might want to add a CA source to increase the calculated concentration for this source beyond the 83% of the measured CA concentration and improve the total R/U ratio shown in the Species Concentrations table. The LIMEDUST source profile is available, and this is a source of CA.

To view the current program input status and codes for sources and species for additional additions and deletions, type:

P INFO

This will give the following display:

```

***CURRENT STATUS***
CMB SITE: ARBAB14      YEAR: 83   DATE: 0617
FINE  SIZE FRACTION
DURATION: 24  START HOUR: 0
SPECIES FINE COARSE FIT
1  TOTAL
35 BR      *      *
82 PB      *      *
29 CU      *      *
30 ZN      *      *
28 NI      *      *
22 TI      *      *
23 V       *      *
24 CR      *      *
25 MN      *      *
26 FE      *      *
19 K       *      *
20 CA      *      *
14 SI      *      *
17 CL      *      *
16 S       *      *

```

Pause.

Please press <return> to continue.

According to this table, the code for CL (its atomic number) is 17.

Press <enter> to continue the information display:

	SOURCES	FINE	COARSE	FIT	
1	ROILCMB	*	*		Residual oil combustion (commercial)
2	LIMEDUST				Limestone dust
3	PRPBSML				Primary lead smelting, ore concentrate
4	PRPBSMCM				Primary lead smelting, ore concentrate, composite
5	TRANCM79	*	*		Transportation composite, Portland (1979)
6	PRDMSMT				Paved road dust, Missoula
7	PRDJUAL				Paved road dust, Juneau
8	PRDLWID				Paved road dust, Lewiston, Idaho
9	PRDPRTOR	*	*		Paved road dust, Portland
10	PRDALAB				Paved road dust, Alabama
11	RESWDCM				Residential wood combustion; composite
12	SLASHBN1				Slash burning
13	AGRFLDBN	*	*		Agricultural field burning
14	SULFATE	*	*		Sulfate single source

ENTER COMMAND

In this table, the species and source categories that were used in the previous fit are indicated with an asterisk. (The actual display as shown in the CMB output does not include the lower-case descriptions shown above). From this table, the code for the LIMEDUST source is 2.

To add the LIMEDUST source, enter:

AS

The response is

SIZE IS FINE
INPUT CODE OF ADDED SOURCE

Enter the code for LIMEDUST, 2:

The response is:

INPUT CODE OF ADDED SOURCE

If more sources are to be added, type the code for the next source. Otherwise, press <enter> to return to the command mode:

ENTER COMMAND

Now, to delete the species CL, code 17, type:

DE

The response is:

SIZE IS FINE
INPUT CODE OF DELETED SPECIES

Delete CL by entering its code:

17

The response is:

INPUT CODE OF DELETED SPECIES

If additional species are to be deleted, enter their code, followed by <enter>. Otherwise, return to the command mode by pressing <enter>. The computer will ask for the next command:

ENTER COMMAND

Run the model with the added source and without the deleted species with the entry:

CMB

The same displays will appear that were displayed previously but will include the added source and will not include the deleted species:

SOURCE CONTRIBUTION ESTIMATES - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0
 SAMPLE DURATION 24 START HOUR 0 SIZE: FINE
 R SQUARE .97 PERCENT MASS 70.3
 CHI SQUARE .79 DF 8

SOURCE * TYPE	SCE(UG/M3)	STD ERR	TSTAT
1 ROILCMB	.1749	.1919	.9115
2 LIMEDUST	.1013	.2020	.5016
5 TRANCW79	1.1128	.1916	5.8074
9 PRDPRTOR	4.6520	.5015	9.2764
13 AGRFLDBN	5.8482	2.6078	2.2426
14 SULFATE	3.5839	.5674	6.3166

MEASURED CONCENTRATION FINE/COARSE/TOTAL:
 22.0+- 2.2/ 89.0+- 8.9/ 111.0+- 9.2
 Pause.
 Please press <return> to continue.

With the added source LIMEDUST, the percent mass accounted for is now 70.3. However the standard error of the LIMEDUST exceeds the source contribution estimate. Addition of LIMEDUST adds uncertainty without greatly improving the percent mass. Press <enter> for the next table:

UNCERTAINTY/SIMILARITY CLUSTERS VERSION: 6.0 SUM OF CLUSTER SOURCES

1	2	5	1.389+-	.330
1	5		1.288+-	.270
1	2	5	1.389+-	.330

Pause.

Please press <return> to continue.

There are now potential collinearities with sources 1 (ROILCMB), 2 (the added source LIMEDUST), and 5 (TRANCM79).

View the remaining table by pressing <enter>:

SPECIES CONCENTRATIONS - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0
 SAMPLE DURATION 24 START HOUR 0 SIZE: FINE
 R SQUARE .97 PERCENT MASS 70.3
 CHI SQUARE .79 DF 8

SPECIES-I-M	MEAS	CALC	RATIO C/M	RATIO R/U
1 TOT	22.0000+-	2.20000	15.47314+-	2.50999
35 BR *	.04800+-	.01000	.05837+-	.01906
82 PB *	.25700+-	.02570	.24199+-	.03419
29 CU *	.00700<	.01000	.00879<	.02340
30 ZN *	.00800<	.01000	.00982<	.00723
28 NI *	.01200+-	.01000	.01000+-	.00718
22 TI *	.01500+-	.01000	.03034+-	.00570
23 V *	.00800<	.01000	.00709<	.00699
24 CR *	.00300<	.01000	.00247<	.00090
25 MN *	.00500<	.01000	.00609<	.00086
26 FE *	.24800+-	.02480	.32044+-	.04572
19 K *	.41200+-	.05000	.39442+-	.14623
20 CA *	.18000+-	.05000	.18348+-	.02637
14 SI *	1.27300+-	.12730	1.07232+-	.05261
17 CL	.03100<	.05000	.21514<	.11749
16 S *	1.32830+-	.13280	1.32830+-	.12652

ENTER COMMAND

By the fact that there is no asterisk by CL, we know that this species has not been included in the fit. Also, the C/M ratios for CA and for K have both improved with the addition of the LIMEDUST source. Nevertheless, because of the collinearities, and because of the large uncertainty associated with the LIMEDUST source, it has not improved the net result and should probably be removed. Enter:

DS

and at the prompt

SIZE IS FINE
INPUT CODE OF DELETED SOURCE

delete the LIMEDUST source by entering its code:

2

The last CMB run also showed a potential collinearity with sources 1 (ROILCMB) and 5 (TRANCM79, the automotive source. For experimentation, delete the TRANCM79 source. At the prompt:

INPUT CODE OF DELETED SOURCE

delete the TRANCM79 source with the entry:

5

The response is:

INPUT CODE OF DELETED SOURCE

Return to the command mode by pressing <enter>:

ENTER COMMAND

Now re-run CMB. Type:

CMB

The CMB tables are displayed without the LIMEDUST and TRNCM79 sources:

SOURCE CONTRIBUTION ESTIMATES - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0
SAMPLE DURATION 24 START HOUR 0 SIZE: FINE
R SQUARE .64 PERCENT MASS 79.7
CHI SQUARE 9.80 DF 10

SOURCE * TYPE	SCE(UG/M3)	STD ERR	TSTAT
1 ROILCMB	.1972	.2160	.9128
9 PRDPRTOR	5.2451	.5213	10.0617
13 AGRFLDBN	8.6364	3.6360	2.3752
14 SULFATE	3.4594	.5877	5.8864

MEASURED CONCENTRATION FINE/COARSE/TOTAL:.
22.0+- 2.2/ 89.0+- 8.9/ 111.0+- 9.2

Pause.

Please press <return> to continue.

Now 79.7% of the mass is accounted for, but the R SQUARE statistic is low, indicating that species concentrations have been predicted poorly. Also, the CHI SQUARE statistic is unreasonably high, indicating that ambient measurements have not been explained well. Press <enter> to view the next display:

Pause.

Please press <return> to continue.

The collinearities no longer appear as two of the three sources causing the collinearities have been removed. Press <enter> to view the next display:

SPECIES CONCENTRATIONS - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0
 SAMPLE DURATION 24 START HOUR 0 SIZE: FINE
 R SQUARE .64 PERCENT MASS 79.7
 CHI SQUARE 9.80 DF 10

SPECIES-I-M	MEAS	CALC	RATIO C/M	RATIO R/U
1 TOT	22.00000+-	2.20000	17.53805+-	3.45590
35 BR *	.04800+-	.01000	.00367+-	.00347
82 PB *	.25700+-	.02570	.02221+-	.00859
29 CU *	.00700<	.01000	.01122<	.03455
30 ZN *	.00800<	.01000	.00656<	.00951
28 NI *	.01200+-	.01000	.01104+-	.00961
22 TI *	.01500+-	.01000	.03422+-	.00631
23 V *	.00800<	.01000	.00799<	.00942
24 CR *	.00300<	.01000	.00288<	.00108
25 MN *	.00500<	.01000	.00689<	.00099
26 FE *	.24800+-	.02480	.33784+-	.06064
19 K *	.41200+-	.05000	.56412+-	.21593
20 CA *	.18000+-	.05000	.16564+-	.03336
14 SI *	1.27300+-	.12730	1.19746+-	.06023
17 CL	.03100<	.05000	.26773<	.17273
16 S *	1.32830+-	.13280	1.32830+-	.13048

ENTER COMMAND

With the removal of the automotive source, TRNCM79, the species BR and PB are poorly represented, with C/M ratios of .08 and .09, respectively. Also, the R/U ratios for BR and PB are very large in absolute magnitude, meaning that the model has not explained them very well. Obviously, the quality of the fit has degraded with the removal of the automotive source, TRNCM79. It would be wise to add this source back. Enter:

AS

The response is:

SIZE IS FINE
INPUT CODE OF ADDED SOURCE

Now enter the code for the added source:

5

At the prompt:

INPUT CODE OF ADDED SOURCE

press <enter> to return to the command mode:

ENTER COMMAND

Re-execute CMB by typing:

CMB

The CMB output displays are now as follows:

SOURCE CONTRIBUTION ESTIMATES - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0

SAMPLE DURATION 24 START HOUR 0 SIZE: FINE
 R SQUARE .97 PERCENT MASS 71.2
 CHI SQUARE .71 DF 9

SOURCE * TYPE	SCE(UG/M3)	STD ERR	TSTAT
1 ROILCMB	.1783	.1935	.9212
5 TRANCM79	1.1152	.1919	5.8105
9 PRDPRTOR	4.7222	.4871	9.6943
13 AGRFLDBN	6.0646	2.6623	2.2779
14 SULFATE	3.5751	.5685	6.2888

MEASURED CONCENTRATION FINE/COARSE/TOTAL:

22.0+- 2.2/ 89.0+- 8.9/ 111.0+- 9.2

Pause.

Please press <return> to continue.

UNCERTAINTY/SIMILARITY CLUSTERS VERSION: 6.0 SUM OF CLUSTER SOURCES

1 5	1.294+-	.271
1 5	1.294+-	.271

Pause.

Please press <return> to continue.

SPECIES CONCENTRATIONS - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0
 SAMPLE DURATION 24 START HOUR 0 SIZE: FINE
 R SQUARE .97 PERCENT MASS 71.2
 CHI SQUARE .71 DF 9

SPECIES-I-M	MEAS	CALC	RATIO C/M	RATIO R/U
1 TOT	22.00000+-	2.20000	15.65538+-	2.56544
35 BR *	.04800+-	.01000	.05855+-	.01912
82 PB *	.25700+-	.02570	.24253+-	.03428
29 CU *	.00700<	.01000	.00904<	.02427
30 ZN *	.00800<	.01000	.00981<	.00740
28 NI *	.01200+-	.01000	.01018+-	.00736
22 TI *	.01500+-	.01000	.03072+-	.00578
23 V *	.00800<	.01000	.00722<	.00717
24 CR *	.00300<	.01000	.00251<	.00092
25 MN *	.00500<	.01000	.00613<	.00088
26 FE *	.24800+-	.02480	.32417+-	.04699
19 K *	.41200+-	.05000	.40775+-	.15164
20 CA *	.18000+-	.05000	.15624+-	.02684
14 SI *	1.27300+-	.12730	1.08210+-	.05345
17 CL	.03100<	.05000	.22146<	.12180
16 S *	1.32830+-	.13280	1.32830+-	.12675

ENTER COMMAND

The C/M ratios for BR and PB are back to reasonable values. There is still a collinearity with sources 1 (ROILCMB) and 5 (TRANCM79) however. This example is for June 17, a warm month when residual oil contributions are probably at a minimum. Try deleting the ROILCMB source. Enter:

DS

and at the prompt

SIZE IS FINE
 INPUT CODE OF DELETED SPECIES

enter the code for ROILCMB:

1

and return to the command by pressing <enter>:

ENTER COMMAND

Run CMB with the command:

CMB

The first CMB table is now:

SOURCE CONTRIBUTION ESTIMATES - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0
SAMPLE DURATION 24 START HOUR 0 SIZE: FINE
R SQUARE .97 PERCENT MASS 71.0
CHI SQUARE .73 DF 10

SOURCE * TYPE	SCE(UG/M3)	STD ERR	TSTAT
5 TRNCM79	1.1173	.1922	5.8134
9 PRDPRTOR	4.7646	.4862	9.8004
13 AGRFLDBN	6.0889	2.6716	2.2791
14 SULFATE	3.6446	.5679	6.4173

MEASURED CONCENTRATION FINE/COARSE/TOTAL:
22.0+- 2.2/ 89.0+- 8.9/ 111.0+- 9.2
Pause.
Please press <return> to continue.

All of results on this table appear to be reasonable. Press <enter> to see the next table:

UNCERTAINTY/SIMILARITY CLUSTERS VERSION: 6.0 SUM OF CLUSTER SOURCES

Pause.

Please press <return> to continue.

The collinearity has been removed with removal of the ROILCMB source. Press <enter> to see the last table:

SPECIES CONCENTRATIONS - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0

SAMPLE DURATION 24 START HOUR 0 SIZE: FINE

R SQUARE .97 PERCENT MASS 71.0

CHI SQUARE .73 DF 10

SPECIES-I-M	MEAS	CALC	RATIO C/M	RATIO R/U
1 TOT	22.00000+	2.20000	15.61540+	2.57459
35 BR *	.04800+	.01000	.05864+	.01915
82 PB *	.25700+	.02570	.24291+	.03436
29 CU *	.00700<	.01000	.00894<	.02436
30 ZN *	.00800<	.01000	.00915<	.00745
28 NI *	.01200+	.01000	.00063+	.00710
22 TI *	.01500+	.01000	.03080+	.00583
23 V *	.00800<	.01000	.00110<	.00710
24 CR *	.00300<	.01000	.00245<	.00092
25 MN *	.00500<	.01000	.00610<	.00088
26 FE *	.24800+	.02480	.32152+	.04724
19 K *	.41200+	.05000	.40912+	.15225
20 CA *	.18000+	.05000	.15458+	.02698
14 SI *	1.27300+	.12730	1.08993+	.05391
17 CL	.03100<	.05000	.22227<	.12229
16 S *	1.32830+	.13280	1.32830+	.12892

ENTER COMMAND

Removing the ROILCMB source has caused C/M ratios for NI and V to be very low, .05 and .14 respectively. However, the measured V is less than detection limits, and NI is a relatively small portion of the total mass, so delete these elements. Enter:

DE

At the prompt:

SIZE IS FINE
INPUT CODE OF DELETED SPECIES

enter the code for V:

23

At the prompt:

INPUT CODE OF DELETED SPECIES

enter the code for NI:

28

Press <enter> to return to the command mode:

ENTER COMMAND

Run CMB with the command:

CMB

CMB output tables now appear as follows:

SOURCE CONTRIBUTION ESTIMATES - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0
SAMPLE DURATION 24 START HOUR 0 SIZE: FINE
R SQUARE .97 PERCENT MASS 71.0
CHI SQUARE .76 DF 8

SOURCE * TYPE	SCE(UG/M3)	STD ERR	TSTAT
5 TRNCM79	1.1169	.1922	5.8128
9 PRDPRTOR	4.7608	.4862	9.7926
13 AGRFLDBN	6.0929	2.6732	2.2793
14 SULFATE	3.6445	.5680	6.4168

MEASURED CONCENTRATION FINE/COARSE/TOTAL:
22.0+- 2.2/ 89.0+- 8.9/ 111.0+- 9.2

Pause.

Please press <return> to continue.

UNCERTAINTY/SIMILARITY CLUSTERS VERSION: 6.0 SUM OF CLUSTER SOURCES

Pause.

Please press <return> to continue.

SPECIES CONCENTRATIONS - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0
SAMPLE DURATION 24 START HOUR 0 SIZE: FINE
R SQUARE .97 PERCENT MASS 71.0
CHI SQUARE .76 DF 8

SPECIES-I-M	MEAS	CALC	RATIO C/M	RATIO R/U
1 TOT	22.00000+-	2.20000	15.61510+-	2.57596
35 BR *	.04800+-	.01000	.05863+-	.01915
82 PB *	.25700+-	.02570	.24283+-	.03435
29 CU *	.00700<	.01000	.00895<	.02438
30 ZN *	.00800<	.01000	.00915<	.00746
28 NI	.01200+-	.01000	.00063+-	.00710
22 TI *	.01500+-	.01000	.03077+-	.00583
23 V	.00800<	.01000	.00109<	.00710
24 CR *	.00300<	.01000	.00245<	.00092
25 MN *	.00500<	.01000	.00610<	.00088
26 FE *	.24800+-	.02480	.32129+-	.04725
19 K *	.41200+-	.05000	.40932+-	.15235
20 CA *	.18000+-	.05000	.15450+-	.02698
14 SI *	1.27300+-	.12730	1.08909+-	.05387
17 CL	.03100<	.05000	.22239<	.12237
16 S *	1.32830+-	.13280	1.32830+-	.12892

ENTER COMMAND

Results have changed very little with the deletion of NI and V because they were small contributors with relatively large uncertainties.

To see a table showing the contribution of each source to each species' calculated ambient concentration, type the command:

SSCONT

The terminal will show the following display:

$$\text{INDIVIDUAL RATIO} = \frac{\text{CALC SPECIES(PER SOURCE)}}{\text{MEAS SPECIES(ALL SOURCES)}}$$

SPEC\SOURCE	5	9	13	14
1 TOTAL	.051	.216	.277	.166
35 BR	1.163	.020	.038	.000
82 PB	.869	.069	.007	.000
29 CU	.116	.204	.957	.000
30 ZN	.489	.655	.000	.000
28 NI	.017	.036	.000	.000
22 TI	.000	2.031	.020	.000
23 V	.000	.137	.000	.000
24 CR	.000	.714	.102	.000
25 MN	.000	1.171	.049	.000
26 FE	.095	1.152	.049	.000
19 K	.002	.119	.873	.000
20 CA	.078	.645	.135	.000
14 SI	.007	.834	.014	.000
17 CL	1.081	.000	6.093	.000
16 S	.003	.013	.069	.915

Pause.

Please press <return> to continue.

Return to the command mode by pressing <enter>:

ENTER COMMAND

The objective of a CMB analysis is to get the best possible fit using the various criteria described in this example. Once the best fit is produced, save the results on file CMB.LST, the requested output file, by typing:

WRITE

The computer will write the most recent results to the file CMB.LST and return with the message:

WRITTEN

ENTER COMMAND

After the CMB model has been run satisfactorily for the fine fraction, run the model again for the coarse fraction. The fitting sources and species can be set separately for the fine and coarse fractions. Don't be surprised when those selected for the fine particle fit are not applied to the coarse particle fit. The sources and species to be used for the initial fits for the fine and coarse fractions were set in the input files POCARB.DAT and SOCARB.DAT.

Change the size by typing:

SIZE

The computer will respond with the message:

SIZE IS COARSE
ENTER COMMAND

Execute the CMB model again by typing:

CMB

At this point, CMB results using initial fit data for the coarse fraction are as follows:

SOURCE CONTRIBUTION ESTIMATES - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0
SAMPLE DURATION 24 START HOUR 0 SIZE: COARSE
R SQUARE .93 PERCENT MASS 82.6
CHI SQUARE 2.11 DF 10

SOURCE			
* TYPE	SCE(UG/M3)	STD ERR	TSTAT
1 ROILCMB	-.1494	.2746	-.5440
5 TRANCW79	-.0764	.2240	-.3413
9 PRDPRTOR	59.3090	3.6971	16.0419
13 AGRFLDBN	14.0596	5.3522	2.6269
14 SULFATE	.3737	.5587	.6689

MEASURED CONCENTRATION FINE/COARSE/TOTAL:
22.0+- 2.2/ 89.0+- 8.9/ 111.0+- 9.2
Pause.
Please press <return> to continue.

Pause.

Please press <return> to continue.

SPECIES CONCENTRATIONS - SITE: ARBAB14 DATE: 0617 83 VERSION: 6.0
 SAMPLE DURATION 24 START HOUR 0 SIZE: COARSE
 R SQUARE .93 PERCENT MASS 82.6
 CHI SQUARE 2.11 DF 10

SPECIES-I-M	MEAS	CALC	RATIO C/M	RATIO R/U
1 TOT	89.0000+-	8.90000	73.51653+-	5.89693
35 BR *	.01600+-	.01000	.00512+-	.00786
82 PB *	.07900+-	.01000	.20821+-	.08917
29 CU *	.00000<	.01000	.03309<	.05669
30 ZN *	.01900+-	.01000	.06437+-	.02607
28 NI *	.00000<	.01000	-.00565<	.01429
22 TI *	.31600+-	.03160	.59956+-	.10676
23 V *	.00300<	.01000	.01088<	.01442
24 CR *	.00600<	.01000	.02732<	.01013
25 MN *	.06200+-	.01000	.05980+-	.00656
26 FE *	4.02300+-	.40230	3.42048+-	.19157
19 K *	1.59900+-	.15990	1.43993+-	.35317
20 CA *	2.33900+-	.23390	1.83219+-	.13713
14 SI *	16.87100+-	1.68710	16.88387+-	.46938
17 CL *	.18400+-	.05000	.43356+-	.28144
16 S *	.31530+-	.13000	.31530+-	.09997

ENTER COMMAND

Use the same criteria and the same types of commands as those used in the fine fraction analysis to arrive at the best fit for the coarse fraction. With practice, this process will become easier and it will also become easier to anticipate the results of various source and species additions and deletions.

When the best fit for the coarse fraction is achieved, again save the results on file CMB.LST by typing:

WRITE

To which the computer will respond with:

WRITTEN
WRITTEN
ENTER COMMAND

Results for the fine fraction and for the coarse fraction have been saved on file CMB.LST. Now exit from the CMB model by typing:

EXIT

The computer will respond with:

Stop - Program terminated.

Two files have been created during this process. The first file is CMB.LST, which contains CMB model results for the fine fraction and for the coarse fraction, plus similar statistics for TSP. The second file is SUMMRY, which contains the results from both the fine and coarse fractions, combined. The SUMMRY file is best viewed by routing it to the printer. Do this by typing:

C> PRINT SUMMRY

The SUMMRY table shown on the next page was made with the fine fraction analysis completed in this example and with the coarse fraction from experimentation with the initial fit shown in the tables above. This table indicates that over half ($54.444\% \pm 5.792\%$) of the PM10 measured at Bakersfield-Chester on June 17, 1983 is attributable to a geological source, typified in this run by PRDPRTOR (Paved Road Dust, Oregon Profile). In the next phase of this example, Phase III - Source Sub-Type Apportionment, contributions from the general category of geological sources will be apportioned among various sub-types of geological sources.

*** CMB SOURCE CONTRIBUTION SUMMARY ***

RESULTS FOR CMB SITE: ARB814 YEAR: 83 DATE: 0617 VERSION: 6.0
 SAMPLING DURATION: 24 HRS. WITH START HOUR: 0

SOURCE	FINE			COARSE			TOTAL		
	UG/M3	%	UG/M3	UG/M3	%	UG/M3	UG/M3	%	
LIMEDUST	.000 +- .000	.000 +- .000	2.058 +- 1.020	2.312 +- 1.170	2.058 +- 1.020	1.854 +- .932			
TRANCH79	1.117 +- .192	5.077 +- 1.010	.000 +- .000	.000 +- .000	1.117 +- .192	1.006 +- .192			
PRDPRTOR	4.761 +- .486	21.840 +- 3.093	55.672 +- 4.022	62.553 +- 7.717	60.433 +- 4.052	54.444 +- 5.792			
AGRFLDBN	6.093 +- 2.673	27.695 +- 12.462	15.261 +- 5.111	17.147 +- 5.994	21.354 +- 5.766	19.238 +- 5.434			
SULFATE	3.645 +- .568	16.566 +- 3.067	.000 +- .000	.000 +- .000	3.645 +- .568	3.283 +- .579			
CALC.MASS	15.615 +- 2.576	70.978 +- 13.692	72.991 +- 5.978	82.012 +- 10.601	88.606 +- 6.510	79.625 +- 8.324			
MEAS.MASS	22.000 +- 2.200		89.000 +- 8.900		111.000 +- 9.100				

4.4 Phase III - Source Sub-Type Apportionment

This phase uses the source dispersion model ISCST to estimate the relative contributions of sub-groups within the major source categories determined by the CMB model. Because its primary purpose here is to estimate the relative contributions, the accuracy of the model in predicting absolute concentrations is not as important as it would be in most regulatory applications. The absolute values are still available, however, for use in EPA'S "Protocol for Reconciling Differences Among Receptor and Dispersion Models".

The version of ISCST used in the assessment package, ARBISCEP, is from UNAMAP Version 6, adapted for personal computers and modified for error propagation. The modified version, as well as the original version from UNAMAP 6, has given unreasonable results for large numbers of area sources during testing with ARB area sources. (The more conventional application of ISCST is to a single source, or group of sources, with concentrations calculated for a large number of receptors). It is recommended that the total number of sources for any given run be less than about 50.

In the application of the previous section, The CMB model showed that a high percentage of PM10 monitored at the Bakersfield-Chester site on June 17, 1983 was attributable to geological sources, represented by the source profile for paved road dust. In this example of Phase III, we will model source emissions of geological materials such as paved road dust to apportion the total geological source contribution among sub-groups within the geological sources category. The ARB document "Methods for Assessing Area Source Emissions in California", from ARB's Emission Inventory Branch, Stationary Source Control Division, gives CES (Category of Emissions Sources) codes for area sources. Table A - Composite Index of Methodologies, contained on pages vi - ix of that document, is reproduced on the following pages. Category 7 - Fugitive Dust Sources includes geological sub-groups such as Tilling Dust, Cattle Feedlot Dust, etc. For this example, use the following sub-groups, with the indicated CES codes:

Group 1 - Building Construction Dust
CES Codes 47357 - 47373

Group 2 - Road Construction Dust
CES Code 47381

Group 3 - Paved Road Travel Dust
CES Code 47456

The remainder of this section consists of procedural steps for applying ARBISCEP to data for sources in these groups that are contained in the Kern County emissions inventory subsets in directory EMDAT.

TABLE A
COMPOSITE INDEX OF METHODOLOGIES

MANUAL

SECTION #

RESP. ³

AREA SOURCE CATEGORIES

PART I PART II

1. PETROLEUM PROCESSING, STORAGE, & TRANSFER

(A)	A. PETROLEUM PRODUCTION	1-1	-----
	81950 - OIL PRODUCTION FUGITIVE LOSSES - SUMPS AND PITS*		
	81955 - OIL PRODUCTION FUGITIVE LOSSES - VALVES*		
	81960 - OIL PRODUCTION FUGITIVE LOSSES - FITTINGS*		
	81965 - OIL PRODUCTION FUGITIVE LOSSES - PUMPS*		
	81970 - OIL PRODUCTION FUGITIVE LOSSES - COMPRESSORS*		
	82008 - OIL PRODUCTION FUGITIVE LOSSES - WELL HEADS*		
	82016 - OIL PRODUCTION FUGITIVE LOSSES - WELL CELLARS*		
	82026 - OIL PRODUCTION FUGITIVE LOSSES - OIL/WATER SEPARATORS*		
	46435 - OIL PRODUCTION FUGITIVE LOSSES (UNSPECIFIED)		
	82032 - TERTIARY OIL PRODUCTION - STEAM DRIVE WELLS*		
	82040 - TERTIARY OIL PRODUCTION - CYCLIC WELLS*		
	46433 - TERTIARY OIL PRODUCTION WELLS (UNSPECIFIED)		
	46458 - OIL PRODUCTION TANKS		
	46441 - GAS PLANT FUGITIVE LOSSES		
(A)	B. GASOLINE DISPENSING FACILITIES	1-3	-----
	46532 - GASOLINE DISPENSING TANKS - WORKING LOSSES		
	46540 - VEHICLE REFUELING - VAPOR DISPLACEMENT		
	46557 - GASOLINE DISPENSING TANKS - BREATHING LOSSES		
	46565 - VEHICLE REFUELING - SPILLAGE		
(A)	C. MARINE PETROLEUM LOADING	1-4	-----
	46573 - TANKER LOADING - CRUDE OIL		
	46581 - TANKER LOADING - GASOLINE		
	46589 - TANKER LOADING - JET FUEL		
	46607 - BARGE LOADING - CRUDE OIL		
	46631 - BARGE LOADING - GASOLINE		
	46706 - BARGE LOADING - JET FUEL		
(A)	D. MARINE PETROLEUM UNLOADING	1-5	-----
	46714 - LIGHTERING - CRUDE OIL		
	46722 - BALLASTING - CRUDE OIL		
	46730 - BALLASTING - GASOLINE		
(D)	E. BULK GASOLINE STORAGE & TRANSFER	-----	-----
	46466 - BULK PLANTS/TERMINALS - BREATHING LOSSES		
	46474 - BULK PLANTS/TERMINALS - WORKING LOSSES		
	46482 - TANK CARS & TRUCKS - WORKING LOSSES		
(D)	F. NATURAL GAS DISTRIBUTION	-----	0-03
	58685 - NATURAL GAS TRANSMISSION LOSSES		

2. SURFACE COATINGS

(A)	A. ARCHITECTURAL COATINGS	2-1	-----
	46755 - WATER-BASED ARCHITECTURAL COATINGS		
	46763 - OIL-BASED ARCHITECTURAL COATINGS		
	46771 - CLEANUP & THINNING SOLVENTS		
(A)	B. COMMERCIAL COATING	2-2	-----
	46789 - AUTO REFINISHING		
(A)	C. INDUSTRIAL COATING	2-3	-----
	66613 - MARINE COATINGS		
	66621 - PAPER COATINGS		
	66639 - FABRIC COATINGS		
	66647 - METAL FURNITURE & FIXTURE COATINGS		
	66654 - CAN & COIL COATINGS		
	66662 - METAL PARTS & PRODUCTS COATINGS		
	66670 - WOOD FURNITURE & FIXTURE COATINGS		
	46748 - INDUSTRIAL COATINGS (UNSPECIFIED)		

3. OTHER SOLVENT USE

(A)	A. DRY CLEANING	3-1	-----
	46797 - PETROLEUM SOLVENT DRY CLEANING		
	46805 - PERCHLOROETHYLENE DRY CLEANING		
(A)	B. DEGREASING - INDUSTRIAL	3-2	-----
	46813 - MANUFACTURING DEGREASING - PETROLEUM SOLVENTS		
	46821 - MANUFACTURING DEGREASING - SYNTHETIC SOLVENTS		
	46839 - MAINTENANCE DEGREASING - ALL SOLVENTS		
(A)	C. DEGREASING - COMMERCIAL	3-3	-----
	46847 - COMMERCIAL DEGREASING - PETROLEUM SOLVENTS		
	46854 - COMMERCIAL DEGREASING - SYNTHETIC SOLVENTS		
(D)	D. ASPHALT PAVING	3-4	0-04
	46870 - CUTBACK ASPHALT		
	46889 - ROAD OILS		
	46896 - HOT-MIX ASPHALT		
	46904 - EMULSIFIED ASPHALT		
	82057 - ASPHALT PAVING (UNSPECIFIED)*		
(A)	E. NON-AEROSOL CONSUMER PRODUCTS USE	3-5	-----
	46912 - NON-AEROSOL CONSUMER PRODUCTS - ALL SOLVENTS		
(A)	F. AEROSOL CONSUMER PRODUCTS USE	3-6	-----
	58693 - AEROSOL CONSUMER PRODUCTS - SYNTHETIC PROPELLENTS		
	58701 - AEROSOL CONSUMER PRODUCTS - NON-SYNTHETIC PROPELLENTS		
(D)	G. ASPHALT ROOFING	-----	-----
	66720 - ASPHALT ROOFING		
(D)	H. PRINTING	-----	-----

66829 - PRINTING

- (D) I. OTHER (MISCELLANEOUS) SOLVENT USES -----
 46862 - MISCELLANEOUS INDUSTRIAL SOLVENT USES -----

4. OTHER SOURCES OF ORGANIC GASES

- (A) A. PESTICIDE APPLICATION ----- 4-1 -----
 47092 - AGRICULTURAL SYNTHETIC PESTICIDES
 47100 - DOMESTIC SYNTHETIC PESTICIDES
 47118 - CREOSOTE APPLICATION
 47126 - AGRICULTURAL NON-SYNTHETIC PESTICIDES
 47134 - DOMESTIC NON-SYNTHETIC PESTICIDES
 (D) B. MUNICIPAL WASTE DISPOSAL ----- D-05 ² -----
 57281 - MUNICIPAL WASTE DISPOSAL (BIODEGRADATION)
 (D) C. VOLATILE ORGANIC WASTE DISPOSAL -----
 82065 - VOLATILE ORGANIC WASTE DISPOSAL (EVAPORATION)*

5. FUEL COMBUSTION

- (D) A. PETROLEUM PRODUCTION-RELATED FUEL COMBUSTION -----
 82073 - PETROLEUM PRODUCTION FUEL COMBUSTION - LIQUID FUELS*
 82081 - PETROLEUM PRODUCTION FUEL COMBUSTION - GASEOUS FUEL*
 (D) B. OTHER INDUSTRIAL FUEL COMBUSTION ----- 5-1 -----
 66787 - INDUSTRIAL STATIONARY I. C. ENGINES - NATURAL GAS
 82089 - INDUSTRIAL STATIONARY I. C. ENGINES - DIESEL*
 82107 - INDUSTRIAL STATIONARY I. C. ENGINES - OTHER FUELS*
 47142 - INDUSTRIAL NATURAL GAS COMBUSTION (UNSPECIFIED)
 66785 - INDUSTRIAL L.P.G. COMBUSTION
 66803 - INDUSTRIAL DISTILLATE OIL COMBUSTION
 (D) C. COMMERCIAL FUEL COMBUSTION ----- 5-2 -----
 47159 - COMMERCIAL DISTILLATE OIL COMBUSTION
 47183 - COMMERCIAL RESIDUAL OIL COMBUSTION
 58727 - COMMERCIAL L.P.G. COMBUSTION
 58735 - COMMERCIAL NATURAL GAS COMBUSTION - SPACE HEATING
 58743 - COMMERCIAL NATURAL GAS COMBUSTION - WATER HEATING
 47167 - COMMERCIAL NATURAL GAS COMBUSTION (UNSPECIFIED)
 (A) D. RESIDENTIAL FUEL COMBUSTION ----- 5-3 -----
 47209 - RESIDENTIAL DISTILLATE OIL COMBUSTION
 47217 - RESIDENTIAL L.P.G. COMBUSTION
 82115 - RESIDENTIAL WOOD COMBUSTION - WOOD STOVES*
 82123 - RESIDENTIAL WOOD COMBUSTION - FIREPLACES*
 47225 - RESIDENTIAL WOOD COMBUSTION (UNSPECIFIED)
 54565 - RESIDENTIAL NATURAL GAS COMBUSTION - SPACE HEATING
 54577 - RESIDENTIAL NATURAL GAS COMBUSTION - WATER HEATING
 54585 - RESIDENTIAL NATURAL GAS COMBUSTION - COOKING
 47191 - RESIDENTIAL NATURAL GAS COMBUSTION (UNSPECIFIED)
 (D) E. AGRICULTURAL FUEL COMBUSTION ----- D-06 -----
 47233 - ORCHARD HEATERS
 (D) F. OTHER FUEL COMBUSTION -----
 74682 - CO-GENERATION

6. WASTE BURNING & UNPLANNED FIRES

- (A) A. WASTE BURNING ----- 6-1 -----
 47241 - AGRICULTURAL BURNING - PRUNINGS
 47258 - AGRICULTURAL BURNING - FIELD CROPS
 47266 - WEED ABATEMENT
 47274 - FOREST MANAGEMENT
 47282 - RANGE IMPROVEMENT
 82131 - WASTE BURNING*
 (D) B. OTHER PLANNED OPEN BURNING -----
 47290 - NON-AGRICULTURAL OPEN BURNING
 (A) C. WILDFIRES ----- 6-2 -----
 47308 - WILDFIRES - GRASS & WOODLAND
 47316 - WILDFIRES - TIMBER & BRUSH
 (A) D. OTHER UNPLANNED FIRES ----- 6-3 -----
 47324 - STRUCTURAL FIRES
 57307 - AUTOMOBILE FIRES

7. FUGITIVE DUST SOURCES

- (A) A. TILLING DUST ----- 7-1 -----
 47332 - TILLING DUST
 (A) B. CATTLE FEEDLOT DUST ----- 7-2 -----
 47340 - CATTLE FEEDLOT DUST
 (A) C. BUILDING CONSTRUCTION DUST ----- 7-3 -----
 47357 - BUILDING CONSTRUCTION DUST - RESIDENTIAL
 47365 - BUILDING CONSTRUCTION DUST - COMMERCIAL
 47373 - BUILDING CONSTRUCTION DUST - INDUSTRIAL
 54551 - BUILDING CONSTRUCTION DUST - INSTITUTIONAL
 60400 - BUILDING CONSTRUCTION DUST - GOVERNMENTAL
 82149 - BUILDING CONSTRUCTION DUST (UNSPECIFIED)*
 (A) D. ROAD CONSTRUCTION DUST ----- 7-4 -----
 47381 - ROAD CONSTRUCTION DUST
 (A) E. PAVED ROAD TRAVEL DUST ----- 7-5 -----
 47456 - PAVED ROAD TRAVEL DUST
 (A) F. UNPAVED ROAD TRAVEL DUST - NON-FARM ROADS ----- 7-6 -----
 47399 - UNPAVED ROAD TRAVEL DUST - CITY & COUNTY ROADS
 47407 - UNPAVED ROAD TRAVEL DUST - U.S. FOREST & PARK ROADS
 47415 - UNPAVED ROAD TRAVEL DUST - TIMBER PRODUCTION ROADS
 47423 - UNPAVED ROAD TRAVEL DUST - B.L.H. ROADS
 82156 - UNPAVED ROAD TRAVEL DUST (UNSPECIFIED)*
 (A) G. UNPAVED ROAD TRAVEL DUST - FARM ROADS ----- 7-7 -----
 47431 - UNPAVED ROAD TRAVEL DUST - FARM ROADS

8. OFF-ROAD VEHICLES & MOBILE EQUIPMENT

(A)	A. OFF-ROAD USE OF MOTORCYCLES -----	8-1	-----
	47464 - OFF-ROAD USE OF MOTORCYCLES		
(A)	B. LIGHT-DUTY INDUSTRIAL EQUIPMENT -----		-----
	54379 - LIGHT-DUTY INDUSTRIAL EQUIPMENT - DIESEL		
	54387 - LIGHT-DUTY INDUSTRIAL EQUIPMENT - GASOLINE		
	54429 - LIGHT-DUTY INDUSTRIAL EQUIPMENT - L.P.G.		
(A)	C. HEAVY-DUTY NON-FARM EQUIPMENT -----		-----
	82164 - HEAVY-DUTY NON-FARM EQUIPMENT - GASOLINE*		
	54593 - HEAVY-DUTY NON-FARM EQUIPMENT - DIESEL*		
(A)	D. HEAVY-DUTY FARM EQUIPMENT -----	8-5	-----
	81919 - HEAVY-DUTY FARM EQUIPMENT - GASOLINE		
	81927 - HEAVY-DUTY FARM EQUIPMENT - DIESEL		
(A)	E. OFF-ROAD RECREATIONAL VEHICLES -----	8-6	-----
	47514 - SNOWMOBILES		
	54411 - FOUR-WHEEL DRIVE VEHICLES		
(A)	F. LAWN & GARDEN UTILITY EQUIPMENT -----	8-7	-----
	47449 - LAWN & GARDEN UTILITY EQUIPMENT - RESIDENTIAL		
	66746 - LAWN & GARDEN UTILITY EQUIPMENT - COMMERCIAL		

9. OTHER MOBILE SOURCES

(A)	A. AGRICULTURAL AIRCRAFT -----	9-1	-----
	47563 - AGRICULTURAL AIRCRAFT (CROP DUSTING)		
(D)	B. OTHER AIRCRAFT -----		D-10
	47555 - JET AIRCRAFT - COMMERCIAL		
	47571 - JET AIRCRAFT - MILITARY		
	47589 - JET AIRCRAFT - CIVIL		
	57315 - PISTON AIRCRAFT - COMMERCIAL		
	57323 - PISTON AIRCRAFT - MILITARY		
	57331 - PISTON AIRCRAFT - CIVIL		
(A)	C. LOCOMOTIVES -----	9-2	-----
	47597 - LOCOMOTIVES - ROAD HAULING		
	47605 - LOCOMOTIVES - SWITCHING		
(A)	D. TRANSPORT REFRIGERATION UNITS -----	9-3	-----
	54353 - TRANSPORT REFRIGERATION UNITS - DIESEL		
	54361 - TRANSPORT REFRIGERATION UNITS - GASOLINE		
(A)	E. RECREATIONAL & COMMERCIAL BOATS -----	9-4	-----
	58602 - RECREATIONAL BOATS - DIESEL		
	58610 - RECREATIONAL BOATS - GASOLINE		
	58628 - COMMERCIAL BOATS - DIESEL		
	58636 - COMMERCIAL BOATS - GASOLINE		
(D)	F. SHIPS -----		
	47613 - SHIPS MANEUVERING - U.S. STEAM SHIPS		
	47621 - SHIPS MANEUVERING - FOREIGN STEAM SHIPS		
	47639 - SHIPS MANEUVERING - U.S. MOTOR SHIPS		
	47647 - SHIPS MANEUVERING - FOREIGN MOTOR SHIPS		
	47654 - SHIPS MANEUVERING - TUGBOATS		
	47662 - SHIPS BERTHING - U.S. STEAM SHIPS		
	47670 - SHIPS BERTHING - FOREIGN STEAM SHIPS		
	47688 - SHIPS BERTHING - U.S. MOTOR SHIPS		
	47696 - SHIPS BERTHING - FOREIGN MOTOR SHIPS		
	58644 - SHIPS IN-TRANSIT - U.S. STEAM SHIPS		
	58651 - SHIPS IN-TRANSIT - FOREIGN STEAM SHIPS		
	58669 - SHIPS IN-TRANSIT - U.S. MOTOR SHIPS		
	58677 - SHIPS IN-TRANSIT - FOREIGN MOTOR SHIPS		
	82172 - SHIPS (UNSPECIFIED)*		

10. INDUSTRIAL & OTHER PROCESSES

(A)	A. WINE FERMENTATION -----	10-1	-----
	47068 - WINE FERMENTATION		
(A)	B. WINE AGING -----	10-2	-----
	60467 - WINE AGING		
(D)	C. COOKING -----	10-3	-----
	60418 - COMMERCIAL CHARBROILING		
	66811 - DEEP FAT FRYING		
	82180 - COOKING (UNSPECIFIED)*		
(D)	D. BAKING -----		D-11
	57349 - BAKERIES		
(D)	E. CHEMICAL PROCESSES -----		
	46938 - SYNTHETIC RUBBER MANUFACTURING		
	46946 - GENERAL PLASTICS MANUFACTURING		
	74674 - FIBERGLASS IMPREGNATION & FABRICATION		
	46953 - SODIUM CARBONATE (SODA ASH) PRODUCTION		
	46961 - OTHER (MISCELLANEOUS) CHEMICAL PROCESSES		
(D)	F. METALLURGICAL PROCESSES -----		
	46979 - SECONDARY METAL PRODUCTION		
(D)	G. MINERAL PROCESSING -----		
	46995 - SAND & GRAVEL EXCAVATION & PROCESSING		
	47001 - ASPHALTIC CONCRETE PRODUCTION		
	47019 - GRINDING/CRUSHING OF AGGREGATES		
	47027 - SURFACE BLASTING		
	47035 - CEMENT CONCRETE PRODUCTION		
	46987 - OTHER (MISCELLANEOUS) MINERAL PROCESSES		
(D)	H. WOOD PROCESSING -----		
	47043 - WOOD PROCESSING LOSSES		
(D)	I. AGRICULTURAL PROCESSING -----		
	47076 - AGRICULTURAL PROCESSING LOSSES		
	47050 - OTHER (MISCELLANEOUS) AGRICULTURAL LOSSES		
(D)	J. MISCELLANEOUS WASTES -----		
	66905 - LIVESTOCK WASTES		
	66712 - BIOLOGICAL WASTES (UNSPECIFIED)		

- (D) K. UNSPECIFIED INDUSTRIAL PROCESS LOSSES -----
 47084 - INDUSTRIAL PROCESS LOSSES (UNSPECIFIED)
- (D) L. UNSPECIFIED SOURCES -----
 66837 - UNSPECIFIED COMBUSTION SOURCES
 66845 - UNSPECIFIED EVAPORATION SOURCES
 66738 - ALL OTHER UNSPECIFIED SOURCES

- 1. "METHODS FOR ASSESSING AREA SOURCE EMISSIONS IN CALIFORNIA",
 STATE OF CALIFORNIA, AIR RESOURCES BOARD (DECEMBER 1982).
- 2. METHOD BEING PREPARED
- 3. RESP. RESPONSIBILITY FOR ESTIMATING EMISSIONS
 (A) AIR RESOURCES BOARD
 (D) DISTRICT
- * NEW CATEGORIES

The modified ISCST model, ARBISCEP, is contained in directory ARBISC. Enter this directory by typing:

```
C> CD ..\ARBISC
```

and view directory contents by typing:

```
C> DIR
```

The computer will respond with the following display of programs in the ARBISC directory:

```
Volume in drive C is Id1v1
Directory of C:\PM10\ARBISC
```

.	<DIR>	5-20-87	9:07a	
..	<DIR>	5-20-87	9:07a	
ARBISCEP	EXE	348370	10-18-87	3:48p
GETMET	BAT	128	3-09-87	11:01a
GETEM	BAT	256	3-09-87	11:02a
ISC	UNC	128	8-26-87	10:21p
MERGE	BAT	128	9-05-87	2:29p

Executable model ARBISCEP
Batch file for retrieving meteorological data from directory METDAT
Batch file for retrieving emissions data from directory EMDAT
Data file containing uncertainties for ARBISCEP input data
Merges created files ISCSOURC.DAT and ISCMET.DAT into ARBISCEP input data file ARBISCEP.DAT

7 File(s) 1581056 bytes free

Before proceeding with ARBISCEP input data file preparation, make sure that CAPS LOCK is in effect on the keyboard.

Emissions data are contained in the directory EMDAT. Enter this directory with the command

```
C> CD ..\EMDAT
```

and view directory contents by entering:

```
C> DIR
```

The following is a list of EMDAT directory contents:

Volume in drive C is id1v1
Directory of C:\PM10\EMDAT

.	<DIR>	5-20-87	9:25a	
..	<DIR>	5-20-87	9:25a	
CARBSTAK	DAT	161880	1-04-80 4:37p	ARB Stack file
CARBPS	DAT	20864	2-13-87 1:39p	ARB Point Source emissions file
CARBRS	DAT	190464	2-23-87 9:52a	ARB Regional Source emissions file
CARBMS	DAT	59264	2-23-87 9:53a	ARB Mobile Source emissions file
MAKEFILE	EXE	30388	9-03-87 4:08p	Creates control parameter inputs for ARBISCEP
NAMEFILE	DAT	128	3-01-87 3:15p	File containing names of EMREAD input files
EMREAD	EXE	77816	9-05-87 2:55p	Reads, screens, and reformats data in ARB emissions inventory files for ARBISCEP input
ISCEINPUT	DAT	384	9-03-87 11:13p	Standard ARBISCEP control parameter input file
10 File(s) 1810432 bytes free				

Additional intermediate files, output data files, and listings will be created during execution of EMDAT programs.

Return to the ARBISC directory with the command:

```
C> CD ..\ARBISC
```

The first step in Phase III phase is to screen the emissions inventory data for the desired sources and reformat them for ARBISCEP. In terms of execution on a personal computer in the environment defined in this assessment package, this consists of the following sequence of steps:

1. Enter the EMDAT directory.
2. Screen the emissions inventory for selected source categories and format source data using program EMREAD.
3. Create an ARBISCEP source data file, with appropriate program control information, using program MAKEFILE.
4. Return to the ARBISC directory.
5. Retrieve the ARBISCEP source data file from the EMDAT directory.

This sequence can be performed using the batch file GETEM.BAT. Enter:

C> GETEM

With this batch command, the computer will enter the EMDAT directory and begin execution of program EMREAD. The terminal will display the following preface:

THIS PROGRAM READS EMISSION (POINT, REGIONAL, AND MOBILE) FILES IN ARB FORMATS AND CONVERTS TO FORMATS REQUIRED BY THE MODIFIED ISCST MODEL, ARBISCEP. SOURCE COORDINATES ARE SHIFTED TO COORDINATES WITH RESPECT TO AN ORIGIN AT THE BAKERSFIELD-CHESTER SITE (ZONE 11 UTM COORDINATES (METERS) 316615 E AND 3914545N). COORDINATE SHIFTS ACCOUNT FOR THE 29 DEGREE TILT OF THE KERN COUNTY GRID. AREA SOURCES CLOSE TO THE BAKERSFIELD-CHESTER SITE ARE SUBDIVIDED, AFTER THE 29 DEGREE SHIFT, TO 1/4 OR 1/16 CELL SIZE TO KEEP WITHIN THE ISCST-REQUIRED MINIMUM DISTANCE. FOR EACH SOURCE GROUP REQUESTED, AREA (REGIONAL AND MOBILE) SOURCES ARE COMBINED TO KEEP THE TOTAL NUMBER OF SOURCES TO A MINIMUM. EMISSION FILES ARE SCREENED ACCORDING TO THE OPTIONS WHICH FOLLOW:

SCREEN EMISSIONS FILES FOR DAY YEAR AND MONTH CODES (Y/N) ?

?

If Month and Day codes are to be screened for inclusion of sources according to those codes, enter Y. Otherwise, enter N. Month and day codes are described in the ARB document "Modelling Emission Data System - File Formats and Descriptions", from ARB's Technical Support Division, Air Quality Modeling Section. For this example, we will not screen for day, year, and month codes, so enter:

N

The computer will now respond with the query:

INCLUDE POINT SOURCES (Y/N) ?

If point sources are to be included, enter Y. This will result in subsequent queries for appropriate SIC and SCC codes to use for screening point sources. This example will include only area sources, which are contained on the ARB Regional and Mobile Source emissions files, so enter:

N

The next query is:

INCLUDE REGIONAL SOURCES (Y/N) ?

For this example, to screen for area sources contained in the ARB Regional Source emissions file, enter:

Y

The next query is:

INCLUDE MOBILE SOURCES (Y/N) ?

To include area emissions from the Mobile Source emissions file, enter Y. During preparation of this example, it was found that none of the requested CES codes were present in the Mobile Source emissions file. To save time during execution of EMREAD, enter:

N

The next query is:

ENTER POLLUTANT INDICATOR

- 1 = CO
- 2 = NOX
- 3 = SOX
- 4 = TOG
- 5 = TSP

?

ARB emissions inventories include emission rates for all of these pollutants. Select TSP by entering:

5

The next query is:

ENTER MINIMUM EMISSION RATE (KG/DAY) (F8.2)

?

To limit the number of sources pulled from the emissions inventory files, select a reasonable minimum TSP emission rate, in Kg/Day. For this example, enter:

.00001

Subsequent queries regard the portions of the Kern County grid to be searched in terms of "I" and "J" grid cell coordinates. The Bakersfield-Chester site is located in grid cell (37,36). Depending on meteorological conditions, it may be useful to limit the search to grid cells that were generally upwind from the sampler during the sample day. For the present example, include all grid cells adjacent to cell (37,36). Lower and upper "I" cell limits of 36 and 38, and lower and upper "J" cell limits of 35 and 37 will do this. To the prompt:

ENTER LOWER, UPPER "I" GRID CELL LIMITS
LOWER "I" LIMIT (I2)

?

respond:

36

To the prompt:

UPPER "I" LIMIT (12)

?

respond:

38

To the prompt:

ENTER LOWER, UPPER "J" GRID CELL LIMITS
LOWER "J" LIMIT (12)

?

respond:

35

To the prompt:

UPPER "J" LIMIT (12)

?

respond:

37

The next query is:

ENTER FILE NAMES AT KEYBOARD
OR IN NAME FILE ?
1 = KEYBOARD
2 = NAME FILE

?

There are 6 input and output file names to be used by EMREAD, in addition to intermediate data files. These can be entered individually by responding with 1. To save time, and to avoid keypunch errors, it is better to use the name of a file that contains all of the required file names, so respond to this prompt with:

2

The computer responds with a request for the name of the file that contains the names of input and output data file names:

ENTER NAME OF FILE-NAME FILE

?

File names are listed in data file NAMEFILE.DAT. Enter:

NAMEFILE.DAT

The next query is for the number of source groups to be modelled:

ENTER NUMBER OF SOURCE GROUPS:

?

Enter:

3

Subsequent queries request the CES codes to be used for defining source groups. If point sources were to be included, queries would also be included for SIC and SCC codes to be used for defining point source groups. If the Mobile Source emissions file were to be screened, queries for CES codes for mobile sources would also be included. As this example includes only regional source emissions, subsequent prompts will be for groups 1, 2, and 3 regional sources. In response to the prompt:

ENTER LOWER, UPPER CES CODE LIMITS FOR GROUP 1 REGIONAL SOURCES:

LOWER LIMIT (15):

?

enter the lower limit to CES codes for group 1 sources:

47357

In response to the prompt:

UPPER LIMIT (15):

?

enter the upper limit to CES codes for group 1 sources:

47373

In response to the prompt:

ENTER LOWER, UPPER CES CODE LIMITS FOR GROUP 2 REGIONAL SOURCES:

LOWER LIMIT (15):

?

enter the group 2 CES code:

47381

There is only one CES code for group 2 regional sources, so in response to the prompt:

UPPER LIMIT (15):

?

enter the same number:

47381

Similarly for group 3 sources. In response to the prompt:

ENTER LOWER, UPPER CES CODE LIMITS FOR GROUP 3 REGIONAL SOURCES:

LOWER LIMIT (15):

?

enter:

47456

and in response to the prompt:

UPPER LIMIT (15):

?

enter the same number:

47456

EMREAD will now execute. Depending on the number of groups and the number of emissions file searched, it may take awhile. During execution, messages will be displayed on the terminal screen that show the status of program execution. For this example, the following messages will be displayed on the terminal screen:

SEARCHING FOR GROUP 1 SOURCES

SEARCHING REGIONAL SOURCE EMISSIONS FILE...

27 REQUESTED SOURCES WERE FOUND.

SEARCHING FOR GROUP 2 SOURCES

SEARCHING REGIONAL SOURCE EMISSIONS FILE...

9 REQUESTED SOURCES WERE FOUND.

SEARCHING FOR GROUP 3 SOURCES

SEARCHING REGIONAL SOURCE EMISSIONS FILE...

9 REQUESTED SOURCES WERE FOUND.

At the end of program execution, a series of messages will be displayed. The first message is:

TABULATED LISTINGS FOR GROUP "N" ARE IN FILE
GROUP(N).LST. IF AREA SOURCES WERE INCLUDED, ISCST-
FORMATTED DATA FOR INDIVIDUAL (NOT COMBINED) AREA
SOURCES ARE IN FILES GRP(N)TMP.DAT

POINT SOURCES WERE NOT INCLUDED.

MOBILE SOURCES WERE NOT INCLUDED.

Pause. Please press <enter> to continue.

The above message is a reminder that tabulated listings are available for review of the sources in each group that were coded for the ARBISCEP model.

Press <enter> to see the next message:

A TOTAL OF 45 ISCST-FORMATTED SOURCES WERE WRITTEN ON FILE EMOUT.DAT . THIS FILE INCLUDES ALL POINT AND COMBINED AREA SOURCES NUMBERED SEQUENTIALLY FOR INPUT TO ISCST. 0 POINT SOURCES FOR WHICH NO ENTRIES WERE FOUND IN THE STACK FILE ARE NOT INCLUDED. A TOTAL OF 45 SUBDIVIDED AND COMBINED AREA SOURCES WERE WRITTEN AFTER SUMMING OVER 45 UNDIVIDED AREA SOURCES FOUND IN THE REGIONAL SOURCE EMISSIONS FILE, AND 0 MOBILE SOURCES FOUND IN THE MOBILE SOURCE EMISSIONS FILE.

Pause. Please press <enter> to continue.

The total number of area sources that will be included as input to ARBISCEP is 45.

Press <enter> to see the next message, which is a summary of the number of sources in each group. This information must be included with the source control information at the beginning of the ARBISCEP input data deck:

**** SUMMARY OF ISCST-FORMATTED SOURCES ON FILE EMOUT.DAT ****

** GROUP 1 **

	ISCST
SOURCE TYPE	SOURCE NUMBERS
POINT	NONE
AREA	1 TO 15

** GROUP 2 **

	ISCST
SOURCE TYPE	SOURCE NUMBERS
POINT	NONE
AREA	16 TO 30

** GROUP 3 **

	ISCST
SOURCE TYPE	SOURCE NUMBERS
POINT	NONE
AREA	31 TO 45

Pause. Please press <enter> to continue.

Finally, press <enter> to end the program. The final messages from EMREAD will be displayed:

NORMAL TERMINATION

MESSAGES WRITTEN ON FILE MESSAGE.LST

Stop - Program terminated.

The main output from EMREAD is the file EMOUT.DAT, which contains ISCST-formatted data for all sources, including combined area sources, for which concentration estimates will be made by ARBISCEP. The input data file for ARBISCEP must also include control parameter information (title, parameter values, number of groups, etc). A standard ISCST input file, ISCINPUT.DAT, is created by EMREAD, along with a short file, EMGRP.DAT, which is used to prepare the complete ARBISCEP input file, minus meteorological data. This final step is performed with the program MAKEFILE. As MAKEFILE executes, the first query is:

TITLE IS:

***** STANDARD ARB INPUT *****

CHANGE TITLE (Y/N) ?

If the above title is OK, type N. To enter a new title name, type Y. For this example, to use a new title, enter:

Y

The computer will respond with the prompt:

ENTER NEW TITLE:

Enter the new title:

EXAMPLE RUN, BAKERSFIELD-CHESTER, 6/17/83

and press <enter>.

Although ARBISCEP is flexible with regard to the number of sources permitted, it is recommended that the number be kept to less than 50. If there are more sources than allowed by ARBISCEP, a warning message will appear. Otherwise, the following system message will be displayed:

Stop - Program terminated.

Successful execution of file creation programs EMREAD and MAKEFILE results in two files, ISCINPUT.TMP, with the title and program control data, and EMOUT.DAT, with reformatted source data. These two files are then merged into one source file, ISCSOURC.DAT, and copied back to directory ARBISCEP.

At the completion of execution of EMREAD, a message file, MESSAGE.LST, was created that contains more detailed information on program results. It is a good idea to review this file to make sure, for example, that the CES codes and other screening criteria were entered correctly. The following is a listing of the MESSAGE.LST file created in this example and located in the EMDAT directory:

***** GROUP 1 *****

REGIONAL SOURCES:

FILE SEARCHED: CARBRS.DAT

FILE WAS SEARCHED FOR CES CODES
BETWEEN 47357 AND 47373, INCLUSIVE.

NUMBER OF UNDIVIDED AREA SOURCES FOUND: 27

3 AREA SOURCES WERE SUBDIVIDED ONCE.
3 SUBDIVIDED AREA SOURCES WERE SUBDIVIDED AGAIN.

AREA (REGIONAL PLUS MOBILE) SOURCES:

A TOTAL OF 15 COMBINED AREA SOURCES
WERE WRITTEN IN ISCST FORMAT ON FILE EMOUT.DAT

***** GROUP 2 *****

REGIONAL SOURCES:

FILE SEARCHED: CARBRS.DAT

FILE WAS SEARCHED FOR CES CODES
BETWEEN 47381 AND 47381, INCLUSIVE.

NUMBER OF UNDIVIDED AREA SOURCES FOUND: 9

1 AREA SOURCES WERE SUBDIVIDED ONCE.
1 SUBDIVIDED AREA SOURCES WERE SUBDIVIDED AGAIN.

AREA (REGIONAL PLUS MOBILE) SOURCES:

A TOTAL OF 15 COMBINED AREA SOURCES
WERE WRITTEN IN ISCST FORMAT ON FILE EMOUT.DAT

***** GROUP 3 *****

REGIONAL SOURCES:

FILE SEARCHED: CARBRS.DAT

FILE WAS SEARCHED FOR CES CODES
BETWEEN 47456 AND 47456, INCLUSIVE.

NUMBER OF UNDIVIDED AREA SOURCES FOUND: 9

1 AREA SOURCES WERE SUBDIVIDED ONCE.
1 SUBDIVIDED AREA SOURCES WERE SUBDIVIDED AGAIN.

AREA (REGIONAL PLUS MOBILE) SOURCES:

A TOTAL OF 15 COMBINED AREA SOURCES
WERE WRITTEN IN ISCST FORMAT ON FILE EMOUT.DAT

SEARCH WAS LIMITED TO SOURCES WITH EMISSIONS EXCEEDING .10E-04 KG/DAY

SEARCH WAS LIMITED TO GRID CELLS:

I = 36 TO I = 38

J = 35 TO J = 37

TABULATED LISTINGS FOR GROUP "N" ARE IN FILE
GROUP(N).LST. IF AREA SOURCES WERE INCLUDED, ISCST-
FORMATTED DATA FOR INDIVIDUAL (NOT COMBINED) AREA
SOURCES ARE IN FILES GRP(N)TMP.DAT

POINT SOURCES WERE NOT INCLUDED.

MOBILE SOURCES WERE NOT INCLUDED.

A TOTAL OF 45 ISCST-FORMATTED SOURCES WERE WRITTEN
ON FILE EMOUT.DAT . THIS FILE INCLUDES ALL POINT AND
COMBINED AREA SOURCES NUMBERED SEQUENTIALLY FOR INPUT
TO ISCST. 0 POINT SOURCES FOR WHICH NO ENTRIES WERE
FOUND IN THE STACK FILE ARE NOT INCLUDED. A TOTAL OF 45
SUBDIVIDED AND COMBINED AREA SOURCES WERE WRITTEN AFTER
SUMMING OVER 45 UNDIVIDED AREA SOURCES FOUND IN THE
REGIONAL SOURCE EMISSIONS FILE, AND 0 MOBILE SOURCES
FOUND IN THE MOBILE SOURCE EMISSIONS FILE.

***** SUMMARY OF ISCST-FORMATTED SOURCES ON FILE EMOUT.DAT *****

** GROUP 1 **

	ISCST
SOURCE TYPE	SOURCE NUMBERS
POINT	NONE
AREA	1 TO 15

** GROUP 2 **

	ISCST
SOURCE TYPE	SOURCE NUMBERS
POINT	NONE
AREA	16 TO 30

** GROUP 3 **

	ISCST
SOURCE TYPE	SOURCE NUMBERS
POINT	NONE
AREA	31 TO 45

Also, a listing was created for each group that gives source information in a column headed format. These files give the emission rates for each source, among other things, and can be reviewed if it is desired to identify specific sources, within the group, that may be major contributors. The names for these files are GROUPn.LST, where n is the group number. List file GROUP1.LST, created by EMREAD during this example, is shown on the following 3 pages:

GROUP 1 SOURCE LISTINGS

TABULATED LIST OF GROUP 1 REGIONAL (AREA) SOURCES FOR TSP

NOTE: IF DIURNAL CODE SHOWN BELOW IS ZERO, EMISSION RATE UNITS ARE GRAMS PER SQUARE METER PER SECOND. IF DIURNAL CODE IS THREE, UNITS ARE GRAMS PER SQUARE METER PER DAY. IN THE LATTER CASE, MULTIPLICATION BY THE QTK SCALARS ON SUBSEQUENT ISCST RECORDS GIVES UNITS OF GRAMS PER SQUARE METER PER SECOND.

SOURCE NUMBER	SOURCE TYPE	DIURNAL CODE (0 = NO VARIATION)	TSP EMISSION RATE (SEE NOTE)	X COORDINATE (M)	Y COORDINATE (M)	EFFECTIVE EMISSION HEIGHT (M)	LENGTH OF SIDE (M)	CES CODE	AREA SOURCE IN CELL:	
									I	J
1	2	3	.54248E-01	-2353.	-3891.	10.0	2000.	47357	36	36 8 16
2	2	3	.45203E-01	-3322.	-2142.	10.0	2000.	47357	36	36 8 16
3	2	3	.12622E-01	-4252.	-393.	10.0	2000.	47357	36	37 8 16
4	2	3	.35325E-01	-603.	-2922.	10.0	2000.	47357	37	35 8 16
5	2	3	.54833E-01	-1573.	-1172.	10.0	1000.	47357	37	36 8 16
6	2	3	.54833E-01	-573.	-1172.	10.0	1000.	47357	37	36 8 16
7	2	3	.54833E-01	-1573.	-172.	10.0	1000.	47357	37	36 8 16
8	2	3	.54833E-01	-573.	-172.	10.0	500.	47357	37	36 8 16
9	2	3	.54833E-01	-73.	-172.	10.0	500.	47357	37	36 8 16
10	2	3	.54833E-01	-573.	328.	10.0	500.	47357	37	36 8 16
11	2	3	.54833E-01	-73.	328.	10.0	500.	47357	37	36 8 16
12	2	3	.18900E-01	-2543.	577.	10.0	2000.	47357	37	37 8 16
13	2	3	.32332E-01	1146.	-1952.	10.0	2000.	47357	38	35 8 16
14	2	3	.32053E-01	176.	-203.	10.0	2000.	47357	38	36 8 16
15	2	3	.28058E-01	-793.	1547.	10.0	2000.	47357	38	37 8 16

16	2	3	.14377E-01	-2353.	-3891.	10.0	2000.	47365	36	35	8	16
17	2	3	.11295E-01	-3322.	-2142.	10.0	2000.	47365	36	36	8	16
18	2	3	.76275E-02	-4292.	-393.	10.0	2000.	47365	36	37	8	16
19	2	3	.17865E-01	-603.	-2922.	10.0	2000.	47365	37	35	8	16
20	2	3	.22703E-01	-1573.	-1172.	10.0	1000.	47365	37	36	8	16
21	2	3	.22703E-01	-573.	-1172.	10.0	1000.	47365	37	36	8	16
22	2	3	.22703E-01	-1573.	-172.	10.0	1000.	47365	37	36	8	16
23	2	3	.22703E-01	-573.	-172.	10.0	500.	47365	37	36	8	16
24	2	3	.22703E-01	-73.	-172.	10.0	500.	47365	37	36	8	16
25	2	3	.22703E-01	-573.	328.	10.0	500.	47365	37	36	8	16
26	2	3	.22703E-01	-73.	328.	10.0	500.	47365	37	36	8	16
27	2	3	.11182E-01	-2543.	577.	10.0	2000.	47365	37	37	8	16
28	2	3	.11047E-01	1146.	-1952.	10.0	2000.	47365	38	35	8	16
29	2	3	.67050E-01	176.	-203.	10.0	2000.	47365	38	36	8	16
30	2	3	.67298E-01	-793.	1547.	10.0	2000.	47365	38	37	8	16
31	2	3	.62550E-02	-2353.	-3891.	10.0	2000.	47373	36	35	8	16
32	2	3	.68850E-02	-3322.	-2142.	10.0	2000.	47373	36	36	8	16
33	2	3	.60075E-02	-4292.	-393.	10.0	2000.	47373	36	37	8	16
34	2	3	.60075E-02	-603.	-2922.	10.0	2000.	47373	37	35	8	16
35	2	3	.13860E-01	-1573.	-1172.	10.0	1000.	47373	37	36	8	16
36	2	3	.13860E-01	-573.	-1172.	10.0	1000.	47373	37	36	8	16
37	2	3	.13860E-01	-1573.	-172.	10.0	1000.	47373	37	36	8	16
38	2	3	.13860E-01	-573.	-172.	10.0	500.	47373	37	36	8	16
39	2	3	.13860E-01	-73.	-172.	10.0	500.	47373	37	36	8	16
40	2	3	.13860E-01	-573.	328.	10.0	500.	47373	37	36	8	16
41	2	3	.13860E-01	-73.	328.	10.0	500.	47373	37	36	8	16
42	2	3	.89550E-02	-2543.	577.	10.0	2000.	47373	37	37	8	16
43	2	3	.60750E-02	1146.	-1952.	10.0	2000.	47373	38	35	8	16
44	2	3	.54810E-01	176.	-203.	10.0	2000.	47373	38	36	8	16
45	2	3	.60097E-01	-793.	1547.	10.0	2000.	47373	38	37	8	16

GROUP 1 SOURCE LISTINGS

COMBINED GROUP 1 AREA SOURCES (REGIONAL AND MOBILE) FOR TSP

NOTE: IF DIURNAL CODE SHOWN BELOW IS ZERO, EMISSION RATE UNITS ARE GRAMS PER SQUARE METER PER SECOND. IF DIURNAL CODE IS THREE, UNITS ARE GRAMS PER SQUARE METER PER DAY. IN THE LATTER CASE, MULTIPLICATION BY THE QTK SCALARS ON SUBSEQUENT ISCST RECORDS GIVES UNITS OF GRAMS PER SQUARE METER PER SECOND.

SOURCE NUMBER	SOURCE TYPE	DIURNAL CODE (0 = NO VARIATION)	TSP EMISSION RATE (SEE NOTE)	X COORDINATE (M)	Y COORDINATE (M)	EFFECTIVE EMISSION HEIGHT (M)	LENGTH OF SIDE (M)	AREA SOURCE IN CELL:	
								I	J
1	2	3	.74880E-01	-2353.	-3891.	10.0	2000.	36	35
2	2	3	.63363E-01	-3322.	-2142.	10.0	2000.	36	36
3	2	3	.26267E-01	-4292.	-393.	10.0	2000.	36	37
4	2	3	.59198E-01	-603.	-2922.	10.0	2000.	37	35
5	2	3	.91396E-01	-1573.	-1172.	10.0	1000.	37	36
6	2	3	.91396E-01	-573.	-1172.	10.0	1000.	37	36
7	2	3	.91396E-01	-1573.	-172.	10.0	1000.	37	36
8	2	3	.91396E-01	-573.	-172.	10.0	500.	37	36
9	2	3	.91396E-01	-73.	-172.	10.0	500.	37	36
10	2	3	.91396E-01	-573.	328.	10.0	500.	37	36
11	2	3	.91396E-01	-73.	328.	10.0	500.	37	36
12	2	3	.39037E-01	-2543.	677.	10.0	2000.	37	37
13	2	3	.49454E-01	1146.	-1952.	10.0	2000.	38	35
14	2	3	.15392E+00	176.	-203.	10.0	2000.	38	36
15	2	3	.15545E+00	-793.	1547.	10.0	2000.	38	37

Finally, files are created that are temporary files and that contain source data for individual (not combined) area sources in the ISCST format. These intermediate files have names GRPnTMP.DAT, where n is the group number.

All required program control information and source data now reside in the ARBISC directory in the file ISCSOURC.DAT. Now, meteorological data for the day being modeled must be retrieved from the meteorological data directory METDAT using the program METREAD, contained in the METDAT directory. First, review METDAT directory contents. Enter the METDAT directory with the command:

```
C> CD ../METDAT
```

Enter:

```
C> DIR
```

to see the directory listing:

```
Volume in drive C is Id1v1
Directory of C:\PM10\METDAT
```

.	<DIR>		5-20-87	9:26a
..	<DIR>		5-20-87	9:26a
NWSMET	DAT	163456	1-01-80	1:10a
METREAD	EXE	41768	3-03-87	2:17p
RAMMET2	INP	128	1-01-80	1:40a
RAMMET2	EXE	129010	1-01-80	3:12a
RAMMET2	RDM	13568	1-01-80	1:39a
RAMMET2	DAT	147408	1-01-80	3:17a

Digitized hourly surface weather observations from Fresno for 62 Bakersfield-Chester sample days, in ISCST format
 Selects meteorological data for requested day from RAMMET2
 Control parameters for RAMMET2
 Modified version of meteorological pre-processing program RAMMET
 Table of random numbers, input to RAMMET2
 Meteorological data for 62 Bakersfield-Chester sample days in ISCST format, created by RAMMET2

```
8 File(s) 1757184 bytes free
```

All of the programs with titles RAMMET2.*, and the file NWSMET.DAT, are related to the modified meteorological pre-processing program RAMMET2, and were described in Section 3.4.3. For the immediate purpose, the only data file of concern is RAMMET2.DAT, which contains meteorological data for the 62 days with particulate data that were used in previous assessment package phases, already formatted by RAMMET2 for use in ISCST (and ARBISCEP). The program METREAD reads the file RAMMET2.DAT and copies hourly records for the day requested to a new file, ISCMET.DAT.

Return to the ARBISC directory with the command:

```
C> CD ..\ARBISC
```

and execute METREAD, through commands contained in the batch file GETMET.BAT, by typing:

```
C> GETMET
```

Batch file commands will direct the computer to enter the METDAT directory, execute METREAD to create the data file ISCMET.DAT, with meteorological data for the requested day in ISCST format, return to the CMB directory, and retrieve ISCMET.DAT. When METREAD is executed, the first prompt will be:

ENTER NAME OF METEOROLOGICAL DATA FILE.

?

Enter the name of the file that contains ISC-formatted meteorological data for the 62 days:

RAMMET2.DAT

In response to the next prompt:

ENTER YEAR OF REQUESTED METEOROLOGICAL DATA. (12)

?

enter:

83

In response to the next prompt:

ENTER JULIAN DAY OF REQUESTED MET DATA (13)

?

enter the Julian date for June 17, 1983:

168

Finally, in response to the prompt:

ENTER NAME OF OUTPUT FILE.

?

enter:

ISCMET.DAT

The program will search the RAMMET2.DAT file, rewrite the meteorological data for the requested day on file ISCMET.DAT, and conclude with the following messages:

ENTER NAME OF INPUT DATA FILE

In response to this query, type the name of the input data file:

ARBISCEP.DAT

In response to the next query:

ENTER NAME OF LIST FILE

type the name of the file to which ARBISCEP output is to be routed. For this example, use the name ARBISCEP.LST. Enter:

ARBISCEP.LST

The next query is:

USE ERROR PROPAGATION (Y/N) ?

To use error propagation, enter:

Y

The following message will then be displayed:

UNCERTAINTIES MUST BE EXPRESSED AS A PERCENTAGE OF THE VALUE USED IN MODEL EQUATIONS, EXCEPT FOR THE UNCERTAINTY FOR WIND SPEED, ENTERED IN ABSOLUTE UNITS OF METERS PER SECOND, AND THE UNCERTAINTY FOR WIND DIRECTION, ENTERED IN ABSOLUTE UNITS OF AZIMUTH DEGREES.

UNCERTAINTIES MAY BE ENTERED MANUALLY OR IN A DATA FILE BY RESPONDING TO THE FOLLOWING PROMPTS.

UNCERTAINTIES ENTERED AT KEYBOARD OR IN DATA FILE.

(0 = KEYBOARD, 1 = DATA FILE) ?

An entry of 0 will result in a series of prompts requesting values of uncertainties for ARBISCEP input variables. The input data file ISC.UNC contains the following input variable measurement uncertainties:

Source Emission Rate:	+/-	10.0 %
Wind Speed:	+/-	0.5 m/s
Wind Direction	+/-	2.0 degrees
Sigma Y:	+/-	20.0 %
Sigma Z:	+/-	20.0 %
Plume Centerline Height:	+/-	20.0 %
Mixing Height:	+/-	20.0 %
Decay Coefficient:	+/-	30.0 %

Uncertainties for Sigma Y, Sigma Z, and Plume Centerline Height are applied to their model-calculated values. Although the decay coefficient uncertainty is nominally 30 percent, decay coefficients used in this example are zero (no decay).

To read uncertainties from a data file, enter:

1

5.0 ASSESSMENT PACKAGE ENHANCEMENTS

This package contains features that could be enhanced with additional information. Watson et al. (1987) contains descriptions of existing data bases, as well as descriptions of measurements that would optimize model results. The practice session in the preceding section highlights many of the areas where additional information would help clarify the sources of PM_{10} and provide additional confidence in model estimates:

1. Chemical species measured in PM_{10} at the Bakersfield-Chester example did not include nitrates, sulfates, ammonium, soluble elements, organic carbon or elemental carbon. Additional factor might be identified, such as vegetative burning.
2. The example utilized only a few, albeit the most likely, of the source profiles that are available in the Receptor Model Source Composition Library. Inclusion of additional source profiles could enhance the CMB analysis. Also, the user should be aware of new source profile information as it appears in the literature or is acquired by ARB studies.
3. The ISCST model, used in phase III, is essentially a flat terrain model, but it will calculate concentrations for gently rolling terrain. Confidence of estimates in such terrain would be enhanced if elevations for inventoried sources were available. In areas of very complex terrain, an alternative model, designed for such applications, could and should be used.
4. Meteorological data used in the example are from Fresno and are marginally representative of conditions at Bakersfield, especially with respect to wind direction, perhaps the most important variable. Data from a more representative site would certainly increase the confidence of ISCST estimates. Such data exists in various formats, from ARB sites as well as original (undigitized) observations from NWS sites. Even if data is only available in hard copy, only 24 hours of data are needed for a given day and could be manually prepared in a short time. Representative meteorological data could also increase confidence of PCA and CMB analysis results. In PCA, meteorological data could be used with particulate data to associate specific factors with unique meteorological conditions.

Wackter, D.J. and J.A. Foster (1986). "Industrial Source Complex (ISC) Dispersion Model User's Guide - Second Edition - Volumes I and II." EPA-450/4-86-005a. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

Watson, J.G., J.C. Chow, D.L. Freeman, R.T. Egami, P. Roberts and R. Countess (1987). "Model and Data Base Description for California's Level I PM₁₀ Assessment Package." DRI Document 8066-002-1D1, Draft Report. Desert Research Institute, P.O. Box 60220, Reno, NV 89506.